SKYTRAK®

Service Manual

Model 6036

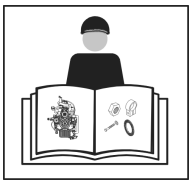
S/N 9B0499 & Before

8990151

Revised February 11, 2005

NQA ISO9001 REGISTERED COMPANY
UKAS QUALITY MANAGEMENT 015

JLG®



Effectivity Page

January, 1997 - 001 - Original Issue.
February 11, 2005 - B - Replaced all branding with JLG.

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SECTION 1
SAFETY PRACTICES

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1.1 INTRODUCTION

Practically all SERVICE work involves the need to drive the forklift. The Owners/Operators Manual, supplied with each forklift, contains detailed safety practices relating to driving and operating. These practices apply to the service technician and should be read, understood, and practiced.

Prior to performing any service on the forklift, consideration should be given to factors that may have an effect upon safety; not only on the mechanic, but also the bystanders.

1.2 SIGNAL WORDS

This symbol means “ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED !” The symbol is used in conjunction with the following signal words to attract your attention to safety messages found throughout this manual. The message that follows the symbol contains important information about SAFETY. To avoid injury and possible death, carefully read and thoroughly understand each message.

The signal word “DANGER” signifies that an **imminently hazardous** situation to a person on or near the forklift exists. This danger to persons is such that it will result in a high likelihood of death or permanent injury if the recommended precautions or practices are not taken.

The signal word “WARNING” signifies that a **potentially hazardous** situation to a person on or near the forklift exists, which could result in death or serious injury if the recommended precautions or practices are not taken.

The signal word “Caution” signifies that a **potentially hazardous** situation to a person on or near the forklift exists, which may result in minor or moderate injury if the recommended precautions or practices are not taken.

IMPORTANT: The information in this manual does not replace any safety rules used in your area. Before operating this forklift, learn the rules and laws for your area. Make sure the machine has the correct equipment according to these rules and laws.

Your safety and the safety of others in the work area depend on your knowledge of correct operating procedures for the machine.

1.3 PERSONAL CONSIDERATIONS

Item	What to do	Why
Clothing	Do not wear loose clothing or jewelry.	Improper clothing can catch on controls or moving parts and cause accidents and/or injury.
Eye Protection	Always wear appropriate eye protection when chiseling, grinding, discing, welding, painting, when repairing hydraulic systems, or checking, testing or charging the battery.	Permanent eye damage can be caused if foreign matter enters the eye.
Breathing Protection	Wear respiratory protection if grinding or painting.	Fumes, dust or paint spray are harmful when inhaled.
Hearing Protection	Always wear ear protection if noise is excessive.	Continuous loud noise can damage your hearing.
Foot Protection	Wear protective footwear with reinforced toe caps and oil-resistant soles.	To protect feet from falling objects and to prevent slipping.
Lifting	Make sure you are capable of lifting an object. Get help or use a sling on large components.	To avoid injury through incorrect handling of heavy components.

1.4 EQUIPMENT CONSIDERATIONS

Item	What to do	Why
Operator's Cab	Before using the forklift, be sure the operator's cab and rear window are secure and serviceable.	The cab protects the operator from possible serious injury or death.
Lifting Equipment	Check all lifting equipment (chains, brackets, hooks, etc.), before use. Be sure equipment is the proper capacity.	To prevent serious injury or death due to falling objects.
	Never stand under a suspended load or raised implement.	To prevent serious injury or death.
Compressed Air	Always use a general purpose nozzle to blow dust, filings, dirt, etc., from work area. Always wear eye protection when using compressed air to clean a work area.	To prevent serious injury to operator and/or co-workers.
	Look around before using an air hose.	To prevent injury to other personnel in the work area.

1.4 EQUIPMENT CONSIDERATIONS (cont.)

Item	What to do	Why
Hand Tools	Always use the proper tool for the job.	Many cuts, abrasions, and/or injuries are caused by defective or improper tools.
	Always keep tools clean and in good working order.	Well maintained tools work better and may prevent injury.
	Always use the Special Service Tools recommended.	These tools will reduce the work, labor and costs.

1.5 GENERAL CONSIDERATIONS

Item	What to do	Why
Solvents	Use only approved cleaning fluids and solvents that are known to be safe.	Certain types of fluid cause damage to components and may cause skin irritation.
Housekeeping	Clean and remove all hazards from the area.	To prevent accidents and injuries.
First Aid	Do not overlook any cut, abrasion, or burn. Have it cleaned and dressed properly.	What appears at first trivial, could become painful and injurious.
	Make sure you know the location of the First Aid Box.	Quick application of first aid procedures.
Cleanliness	Plug all hose ends and connections when removing components. Clean exterior of all parts before repairing. A high pressure or steam cleaner is recommended. Always wear eye protection when steam cleaning.	To prevent dirt and foreign material from entering the system. Dirt and abrasive dust can reduce the efficiency and working life of a component and lead to costly replacement. Permanent eye damage can be caused if foreign matter enters the eye.

1.6 OPERATIONAL CONSIDERATIONS

Item	What to do	Why
Engine	Stop the engine if at all possible before performing any service.	To prevent serious injury and/or death.
Dangerous Start	Place a warning sign on forklifts that are dangerous to start. Disconnect battery leads if leaving the unit unattended.	To prevent serious injury and/or death.

1.6 OPERATIONAL CONSIDERATIONS (cont.)

Item	What to do	Why
Ventilation	Avoid prolonged running of the engine in a closed area with inadequate ventilation.	Exhaust fumes are highly toxic and can kill.
Radiator Cap	Always turn the radiator cap slowly to the first stop to relieve pressure.	Escaping coolant can burn you seriously.
Soft Ground	Never work on a forklift on soft ground. Check for additional ballast. Seek assistance and install suitable supports if necessary.	To prevent serious injury and/or death.
Supports and Straps	Make sure safe and stable supports or straps are installed beneath or around a component or structural member that may fall before commencing work.	To prevent serious injury and/or death.
Oil Pressure	Before loosening hoses or tubes, turn off the engine and operate the controls several times to relieve pressure.	A pressure explosion will cause serious injury.
Pressure Testing	Make sure all test equipment is in good condition. Use only gauges specified. Comply with test procedure specified.	To prevent damage to the system or the equipment, and to eliminate the possibility of personal injury.
Leaving Forklift	Lower carriage to the ground.	To prevent accidental injury.
Parking	Do not park or attempt to service forklift on an incline. If unavoidable, block all wheels.	To prevent serious injury and/or death.
Wheels and Tires	Keep tires inflated to correct pressure. Do not over-inflate tires.	To prevent dangerous travel and load handling. Over-inflation can cause tires to burst and result in personal injury.

1.7 FINAL WORD

The safety precautions and practices in this manual are extremely important. Not following them can cause personal injury or death. Read this section carefully and be sure you understand all the precautions and practices noted before attempting to service the forklift.

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GENERAL INSTRUCTIONS

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2.1 INTRODUCTION

Appropriate service methods and proper repair procedures are essential for safe, reliable operation of the forklift and safety of the individual doing the work. This Maintenance Manual provides **general directions** for accomplishing service and repair work with tested, effective techniques. Following them will assure reliability.

There are many variations in procedures, techniques, tools, and parts for servicing vehicles, as well as work skills. This Manual cannot possibly anticipate all such variations and provide advice or cautions for each one. Accordingly, anyone who intends to depart from the instructions in this Manual must first consider his safety and the vehicle integrity.

2.2 CLEANING

Clean the exterior of all parts before repairing. Dirt and abrasive dust reduce the efficient work life of the part and lead to costly replacement.

Use cleaning fluids and solvents which are suitable for cleaning parts and do not risk the safety of the user. Certain types of fluids damage rubber parts and/or cause skin irritation.

The following precautions must be observed to insure hydraulic cleanliness:

1. Flush hose and tube assemblies with a solvent compatible with hose assemblies. Blow out excess solvent with shop air.
2. Cap hydraulic fittings and protect threads until installation.
3. Cap hoses and tube assemblies until installation
4. Flush hydraulic reservoir, fuel tank, and gear housing with a suitable solvent to remove paint, metal chips, welding shot, etc.
5. Protect system components from airborne contaminants. Plug all cylinder, valve, reservoir, tank, and pump openings until installation.
6. Use clean, filtered oil when filling the system.
7. System cleanliness level must be a minimum ISO code 18/15 particle ratio count.

2.3 REPLACEMENT

Replace O-rings, seals, and gaskets whenever they are disturbed. Never mix new and old seals or O-rings regardless of condition. Always lubricate new seals and O-rings with hydraulic oil before installation.

When replacing parts, **use the correct tool.**

2.4 HOSES AND TUBES

2.4.1 Inspection

1. If the hose end fittings are damaged, always replace hoses and tubes . Damaged, dented, crushed, or leaking hose fittings restrict oil flow and the operation of the parts being served. Fittings showing signs of movement from their original position have failed and must be replaced.
2. Be sure hoses are in good condition. If in doubt, replace them.
3. Replace hoses if the following occur:
   - chafed outer cover
   - concealed corrosion of wire reinforcement.
   - ballooning (**replace immediately !**)
   - kinked, crushed, stretched, or deformed.

2.4.2 Installation

1. When installing a new hose, loosely connect each end and make sure the hose takes up the designed position before tightening the connection. Clamps should be tightened sufficiently to hold the hose without crushing and to prevent chafing.
2. If a hose is replaced on a moving part, be sure it does not foul by moving the part through its complete range of travel.
3. Be sure any hose which has been installed is not kinked or twisted.
4. Free moving, unsupported hoses must never touch each other or related work surfaces. This causes chafing reducing hose life.

2.5 BEARINGS

2.5.1 Removal

1. **Bearings should never be removed unless absolutely necessary.** Always use the recommended puller to reduce the risk of bearing or related component damage.

2. When bearings or bushings are removed, check that the bearing is free from discoloration, nicks, scuffing, and signs of overheating. If in doubt, replace the bearing or bushing.

2.5.2 Cleaning

Bearings acceptable for service should be cleaned in a suitable solvent and immersed in clean lubricating oil until needed.

2.5.3 Installation

1. Be sure bearings are installed with care during servicing, maintenance and repair.
2. Install bearings in either of the following two ways:
   - press fit on rotating parts such as shafts and gears, and
   - push fit into static locations such as reduction gear housings.
3. When possible, always install the bearing into the rotating part first.
4. Use the proper tools or a press when installing a bearing or bushing.
5. In the absence of the proper tools or press, heat the bearings and/or casing in hot oil to assist in the installation.

2.6 PRESSURE TESTING AND ADJUSTMENT

Prior to pressure testing or adjustment, be sure all hoses are in good condition and all fittings tight.

Use a pressure gauge with a range that is large enough to measuring the specified pressure.

Comply with the correct procedure to prevent damage to the system or the equipment and to eliminate the possibility of injury.

Be sure that hydraulic oil is at operating temperature (80 to 120 °F) before adjusting relief valves, pressure reducing valve or sequence valve. If necessary, operate the machine to raise the oil temperature. The oil temperature can be checked by placing a hand against the side or the bottom of the reservoir. If your hand feels too hot to keep against the reservoir, the oil temperature is acceptable.

2.7 TORQUES

2.7.1 Fasteners

All fasteners are plated and equal to SAE grade 5 (PC8.8) unless otherwise specified.

2.7.2 Bolts and Nuts

Unless otherwise specified the following grade 5 (PC8.8) torque values (±10%) apply:

Torque			Torque		
Inch	lb-ft	N m	**mm**	N m	lb-ft
1/4	9	12	6.0	10	7
5/16	18	24	8.0	25	18
3/8	31	42	10.0	50	37
7/16	50	68	---	---	---
1/2	75	105	12.0	80	59
9/16	110	150	14.0	130	95
5/8	150	200	16.0	200	146
3/4	250	340	20.0	360	263
7/8	380	515	22.0	510	372
1.0	585	790	24.0	650	475

2.7.3 Flared Fittings (37°, steel)

1. Align tube and fitting

2. Tighten nut to the following torque:

SAE Size	Torque	
	lb-ft	N m
4	8-12	11-16
6	19-23	26-31
8	38-46	52-63
10	50-58	68-79
12	84-92	114-125
14	100-108	136-147
16	117-129	159-175
20	176-200	239-271
24	251-283	340-384

2.7.4 Straight Thread O-ring Fitting (non-adjustable)

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.
2. Lubricate O-ring with light coating of oil.
3. Torque as follows:

SAE Size	Torque	
	lb-ft	N m
4	22-26	30-35
6	46-54	63-73
8	95-105	129-143
10	125-135	170-183
12	165-175	224-237
16	245-255	332-346
20	270-290	366-393
24	365-385	495-522

2.7.5 Straight Thread O-ring Fitting (adjustable)

1. Inspect and correct both mating parts for burrs, nicks, scratches, or any foreign particles.
2. Lubricate O-ring with light coat of oil.
3. Back off locknut as far as possible.
4. Screw fitting into the port by hand until the backup washer contacts the face of the port and is pushed all the way towards the locknut.
5. To position the fitting, unscrew by the required amount, but not more than one full turn.
6. Hold the fitting in the desired position and torque the locknut as follows:

SAE Size	Torque	
	lb-ft	N m
4	14.5-17.5	20-24
6	37-43	50-58
8	75-85	102-115
10	115-125	156-170
12	155-165	210-224
16	225-235	305-319
20	260-280	353-380
24	340-360	461-488

2.8 PAINTING

Unless otherwise specified, paint all components as follows:

2.8.1 Orange Paint

Use orange paint on all components except as specified in paragraphs 2.8.2 and 2.8.3.

P/N 8528033 .....1 gallon service paint

P/N 8528034 ..... 16 oz Spray can

2.8.2 Black Paint

Use P/N 8528036 ..... 16 oz spray can

Boom Angle Indicator Pointer

Wheels

Brake Pedal

Radiator

Seat Adaptor Plate

Radiator Shroud

Transmission Oil Cooler

Axles

Drive Shafts

Drop Box

Forks

Mirrors and their Brackets

Dash Panels

Instrument Mounting Plate

Air Cleaner

Steering Column

Joystick Panel

Cab Door Handle

2.8.3 White Paint

Use P/N 8528040 ..... 16 oz spray can

Boom Extend Cylinder

2.9 AFTER SERVICE STARTUP AND CHECKS

2.9.1 Starting After Servicing

***NOTE**: Refer to Owners/Operators Manual for engine cold start procedure.*

1. Check fluid levels.
2. Start engine at idle. Check for leaks from hydraulic components, engine, axles, transmission, brakes and reservoirs.
3. Purge systems of air by operating functions.
4. Check for proper operation.
5. Retract all cylinders. Shutdown and check reservoir levels. Recheck levels when oil is cold.
6. Replace hydraulic filter if required.

2.9.2 After Hydraulic Component Servicing

1. Check torque on fastening hardware of components being replaced.
2. Check that hoses are in place and tightly connected.
3. Check hydraulic fluid level and replenish as required.
4. Start forklift and bleed systems of air.
5. Check operation.

2.9.3 After Brake System Servicing

1. Check level of TRAK wet disc brake oil in wheel ends and replenish as required.
2. Bleed brakes.
3. Check wheel end brake pressure.
4. Check operation.

2.9.4 After Fuel System Servicing

1. Bleed fuel system.
2. Fill tank with clean fuel as required.

2.9.5 After Replacing Transmission

1. Check transmission fluid level and replenish as required.
2. Replace transmission filter.
3. Check torque on drive shaft yoke hardware.
4. Refer to the Clark Maintenance Manual for “Servicing Machine After Transmission Overhaul”.

2.9.6 After Tire Servicing

1. Check hydrofill mixture, air pressure and weight of tire (empty and full).
2. Check wheel nut torque.

2.9.7 After Engine Servicing

Consult the qualified service agent for proper procedure before startup.

2.9.8 After Boom Servicing

1. Check wear pads.
2. Check chain tension adjustment.
3. Lubricate all grease points.

2.9.9 After Axle Servicing

1. Check fluid levels.
2. Check torque of drive shaft yoke hardware.
3. Check wheel nut torque.
4. Check toe-in if required.
5. Lubricate all grease points.
6. Refer to Dana Service Manual for “SECTION 1 - General Information”.

2.10 FLUID LEVELS AND LUBRICATION

2.10.1 Wheel Ends

Use the following procedure to check fluid level on the wheel ends:

1. Level the forklift, ground the carriage, shut off engine, and engage the parking lock. Be sure that arrow on wheel end housing is pointing down.

2. Clean the area around the magnetic drain plug and remove the plug and check fluid level. Use only Special TRAK Wet Disc Brake Oil (P/N 8522042) as required to bring level up even with the plug hole.

IMPORTANT: *Other brake oils should not be used! You will lose braking force and brake squealing will occur.*

3. Clean and install drain plug.

2.10.2 Hydraulic Reservoir

With the oil cold and the forklift on a level surface and all hydraulic cylinders retracted, check the sight gauge plug. If oil is visible in the sight gauge plug, the level is satisfactory. If oil level is not visible in the sight gauge, the level is unsatisfactory and hydraulic oil must be added.

2.10.3 Engine Oil

Oil level should be between the full and add mark on the dipstick.

2.10.4 Cooling System

Check level of coolant in overflow bottle. When coolant is hot, bottle should be 3/4 full to full. When coolant is cool, bottle should be 1/4 to 1/2 full. Add coolant as required through the overflow bottle (50/50 mixture of ethylene glycol and water).

2.10.5 Splines

Transmission input shaft splines must be coated with a molybdenum disulfide or Molykote compound.

2.10.6 Drop Box

Remove level plug in drop box and check level of oil. Add Tractor Hydraulic Fluid (THF) as required through the level plug hole with a squeeze bottle. Bring the oil level up even with the level plug hole and install the level plug.

2.10.7 Grease Fittings

1. Coat the following with a multi-purpose lithium-based grease:
   - Hydraulic cylinder pins (10 points)
   - Drive shaft slip joints (3 points)
   - Boom chain sheaves (2 points)
   - Boom pivot pins (2 points)
   - Carriage pivot pins (2 points)
   - Axle pivot pins (4 points)
   - Axle steer knuckles (8 points)
   - Axle tie rod ball joints (4 points)
   - Axle steer cylinder ball joints (8 points)
2. All excess grease must be removed.

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SECTION 3
BOOM

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3.1 BOOM ASSEMBLY

The boom assembly, Fig. 3.1, consists of inner, intermediate, and outer booms. The intermediate boom slides in the outer boom and the inner boom slides in the intermediate boom. As the boom extend/retract cylinder extends or retracts the intermediate boom, a pair of extend chains and one retract chain moves the inner boom in the same direction.

IMPORTANT: *The inner, intermediate and outer boom replacement instructions in paragraphs 3.1.1 through 3.1.3 must be completed in sequence. Replacement of two or more booms as a unit requires special considerations that are not covered in these instructions.*

3.1.1 Inner Boom Replacement

a. Removal

1. Park forklift on level surface, engage park lock and retract boom.

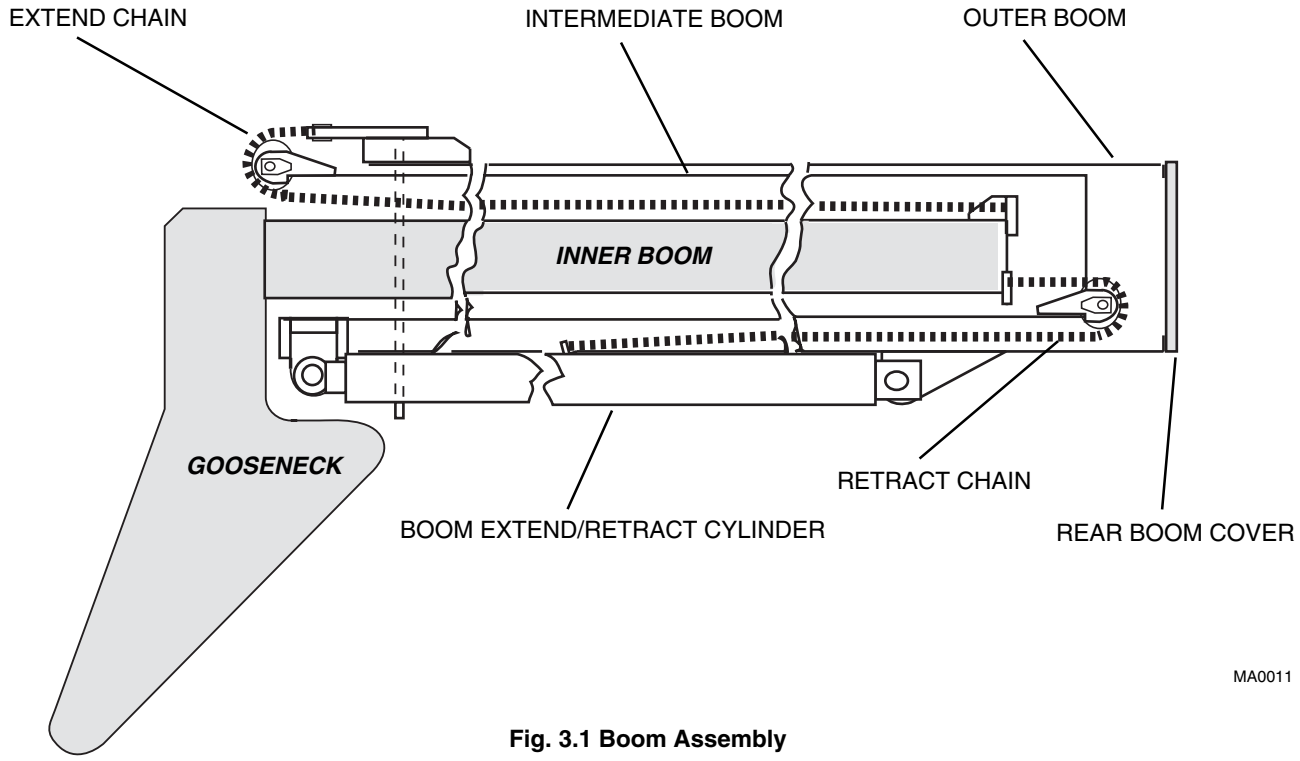


Fig. 3.1 Boom Assembly

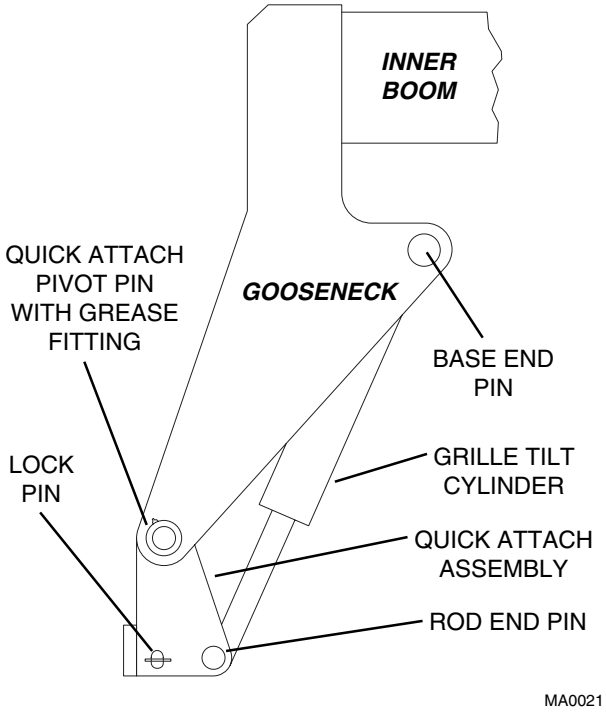


Fig. 3.2 Gooseneck

2. Prepare to replace the inner boom, Fig. 3.2, by removing the grille tilt cylinder as described in paragraph 9.2.4.a.
3. Remove the quick attach pivot pin, Fig. 3.2, and quick attach assembly from the gooseneck.
4. Remove the rear boom cover, Fig. 3.1.
5. Pull the grille tilt cylinder hoses out the rear boom cover opening.
6. Working from the rear boom cover opening, record the number of shims beneath each wear pad as you remove the side and top wear pads from the inner boom, Fig. 3.3.
7. Refer to Fig. 3.1 and remove the locknuts and washers that attach the extend and retract chains to the inner boom.
8. Use a sling and a suitable hoist to slide the inner boom out the front of the intermediate boom.
9. Refer to Fig. 3.3 and remove bottom wear pad from the rear of the inner boom.

b. Inspection and Replacement

1. Inspect the boom and welds and contact JLGif structural damage is detected.
2. Inspect hoses and replace if damaged.
3. Inspect and replace wear pads as described in paragraph 3.1.8.

c. Installation

1. Refer to Fig. 3.3 and install the bottom wear pad on the inner boom. Install a new pad if it is excessively worn (refer to paragraph 3.1.8). Apply Loctite® Removable Threadlocker 242 to the capscrews and torque them to 31 lb-ft (42 N m).
2. Connect the extend chains at the top rear of the inner boom; temporarily secure the other end of the chains to the top front of the inner boom
3. Use slings and a suitable hoist to slide the repaired or new inner boom and extend chains into the intermediate boom.
4. Working through the rear cover opening, temporarily install the top and side inner boom wear pads on the inner boom, Fig. 3.3. Replace pads that are excessively worn. Use the same amount of shimming as used when the pads were removed.

IMPORTANT: *The ends of wear pad attaching capscrews must not protrude beyond the wear pad insert; the ends must range from flush to 0.19" (5 mm) recessed in the wear pad insert (refer to Fig. 3.3).*

5. Check the wear pad gap between the inner boom side and top wear pads and the intermediate boom. The gap should be 0.07 to 0.13" (1,8 to 3,3 mm) and equal for all top and side wear pads. Install or remove shims as required.
6. Install the wear pads by applying Loctite 242 to the capscrews and torquing them to 31 lb-ft (42 N m).
7. Secure the retract chain to the inner boom with washers and locknuts. Make sure the chains are not twisted.
8. Tie the grille tilt cylinder hoses together and push them through the inner boom to the opening at the inner boom gooseneck.
9. Refer to Fig. 3.2 and install the quick attach assembly on the gooseneck with the quick attach pivot pin. Position pin with grease holes facing UP.
10. Using grease fittings at the ends of the pin, lubricate the quick attach pivot pin.
11. Install the grille tilt cylinder as described in paragraph 9.2.4.f.
12. Adjust hose tension as described in paragraphs 3.1.9.

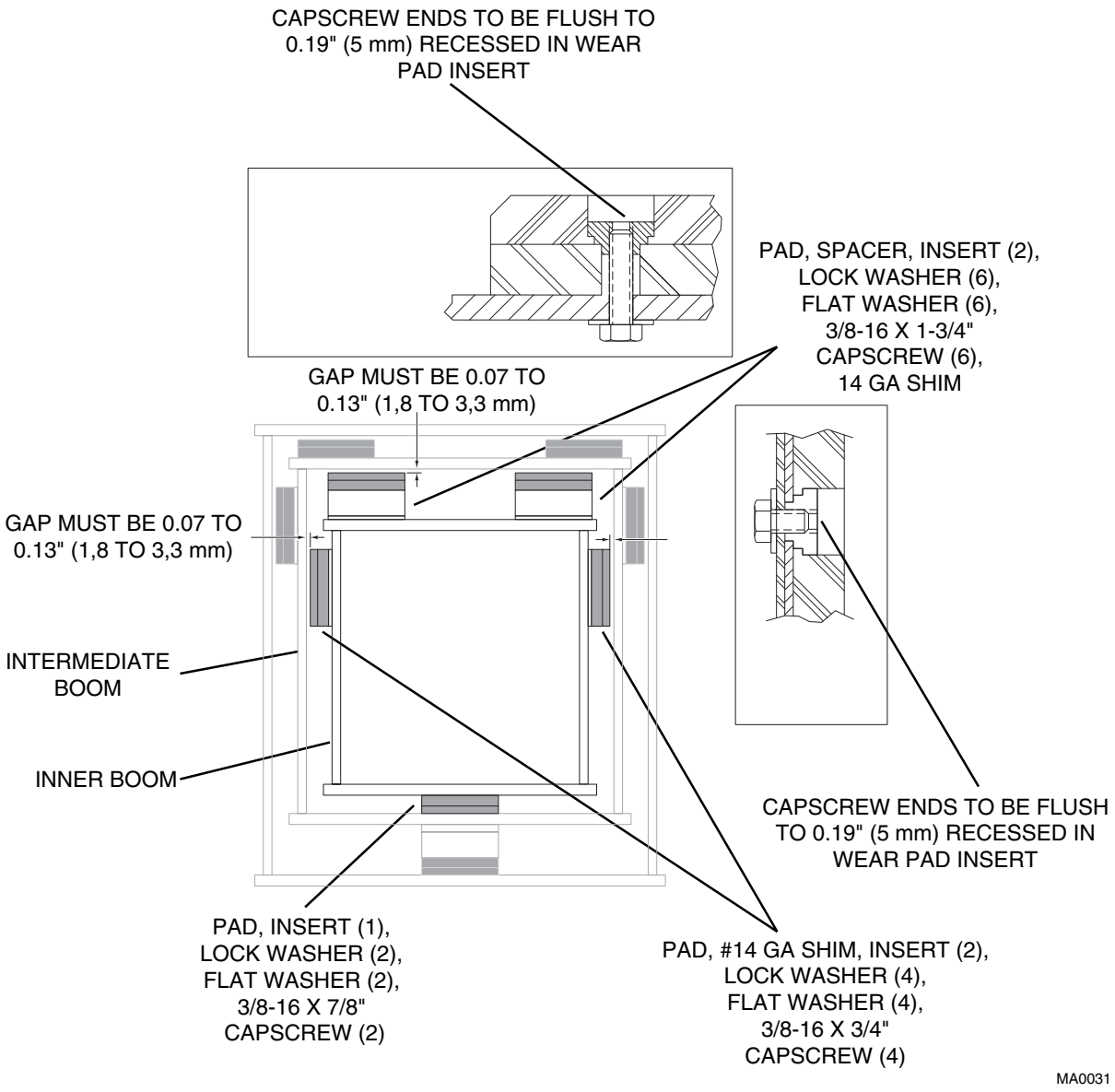

CAPSCREW ENDS TO BE FLUSH TO 0.19" (5 mm) RECESSED IN WEAR PAD INSERT
PAD, SPACER, INSERT (2), LOCK WASHER (6), FLAT WASHER (6), 3/8-16 X 1-3/4" CAPSCREW (6), 14 GA SHIM
GAP MUST BE 0.07 TO 0.13" (1,8 TO 3,3 mm)
GAP MUST BE 0.07 TO 0.13" (1,8 TO 3,3 mm)
INTERMEDIATE BOOM
INNER BOOM
CAPSCREW ENDS TO BE FLUSH TO 0.19" (5 mm) RECESSED IN WEAR PAD INSERT
PAD, INSERT (1), LOCK WASHER (2), FLAT WASHER (2), 3/8-16 X 7/8" CAPSCREW (2)
PAD, #14 GA SHIM, INSERT (2), LOCK WASHER (4), FLAT WASHER (4), 3/8-16 X 3/4" CAPSCREW (4)
MA0031

Fig. 3.3 Rear Wear Pads Attached to Inner Boom

13. Check and adjust chain tension as described in paragraphs 3.1.6 and 3.1.7.
14. Refer to Fig. 3.1 and install the rear boom cover.

3.1.2 Intermediate Boom Replacement

a Removal

1. Refer to paragraph 3.1.1.a and remove the inner boom.
2. Remove the rod end pin, Fig. 3.4, and retaining rings that attach the rod end of the boom extend/retract cylinder to the intermediate boom. Lower the rod end to the anti-buckle bar.
3. Working from the rear boom cover opening, record the number of shims beneath each wear pad as you remove the side and top wear pads from intermediate boom, Fig. 3.6.

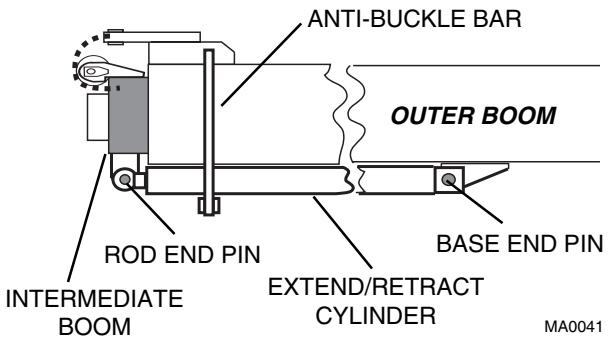


Fig. 3.4 Extend/Retract Cylinder

4. Use a sling and a suitable hoist to slide the intermediate boom out the front of the outer boom.
5. Record the number of shims beneath each wear pad as you remove the rear bottom, Fig. 3.6, and all front wear pads, Fig. 3.5, from the intermediate boom.
6. Examine the chain sheaves for wear and replace if necessary.

b. Inspection and Replacement

1. Inspect the boom and welds and contact JLG if structural damage is detected.

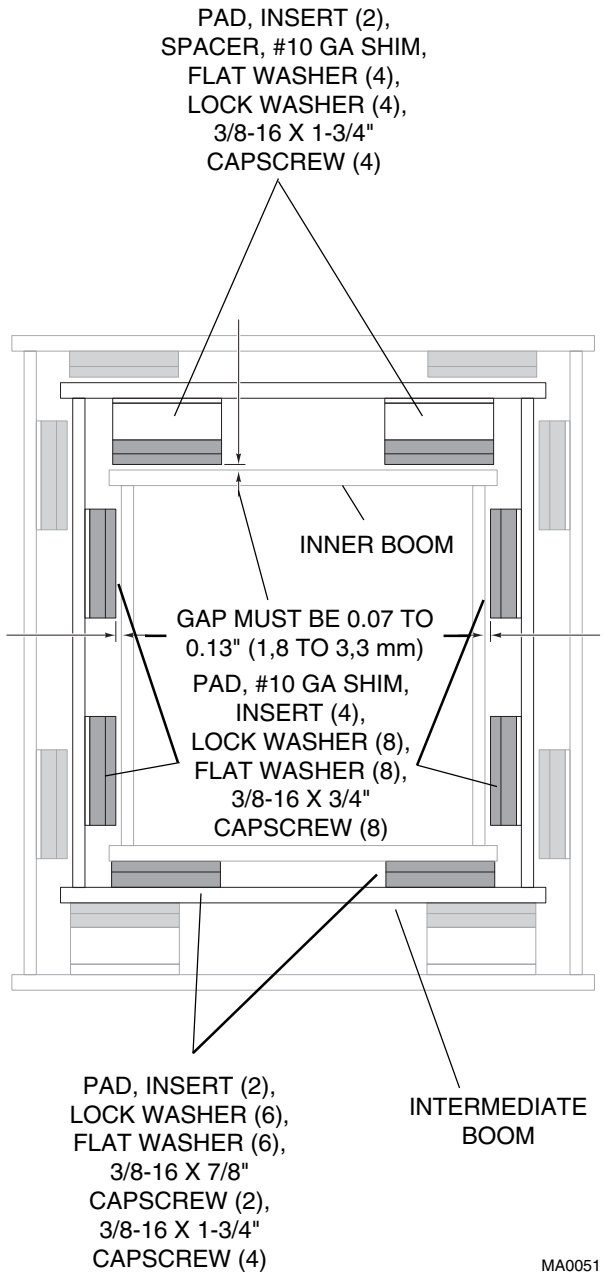


Fig. 3.5 Front Wear Pads Attached to Intermediate Boom

2. Inspect hoses and replace if damaged.
3. Inspect and replace wear pads as described in paragraph 3.1.8.

c. Installation

1. Refer to Fig. 3.6 and install the rear bottom wear pad, Fig. 3.6, on the intermediate boom. Install a new pad if it is excessively worn (refer to paragraph 3.1.8). Apply Loctite® Removable Threadlocker 242 to the capscrews and torque them to 31 lb-ft (42 N m).
2. Using a sling and a suitable hoist, slide the repaired or new intermediate boom into the outer boom.
3. Working through the rear boom cover opening, refer to Fig. 3.6 and temporarily install the rear top and side wear pads on the intermediate boom. Replace pads that are excessively worn. Use the same amount of shimming as used when the pads were removed.

IMPORTANT: *The ends of wear pad attaching capscrews must not protrude beyond the wear pad insert; the ends must range from flush to 0.19" (5 mm) recessed in the wear pad insert (refer to Fig. 3.3).*

4. Refer to paragraph 3.1.1.c and install the inner boom.
5. Connect the extend chains at the front of the outer boom.
6. On the front of the intermediate boom, check the gap between the intermediate boom side and top wear pads and the inner boom, Fig. 3.5. The gap should be 0.07 to 0.13 inches (1,8 to 3,3 mm) and equal on all sides. Remove or install shims as required.
7. Working through the rear boom cover opening, refer to Fig. 3.6 and check the gap between the intermediate boom side and top wear pads and the outer boom. The gap should be 0.07 to 0.13 inches (1,8 to 3,3 mm) and equal on all sides. Remove or install shims as required.
8. Install the wear pads by applying Loctite 242 to the capscrews and torquing them to 31 lb-ft (42 N m).
9. Refer to Fig. 3.4 and apply anti-seize compound to the rod end pin. Secure the rod end of the boom extend/retract cylinder to the intermediate boom with the rod end pin, Fig. 3.4 and retaining rings.

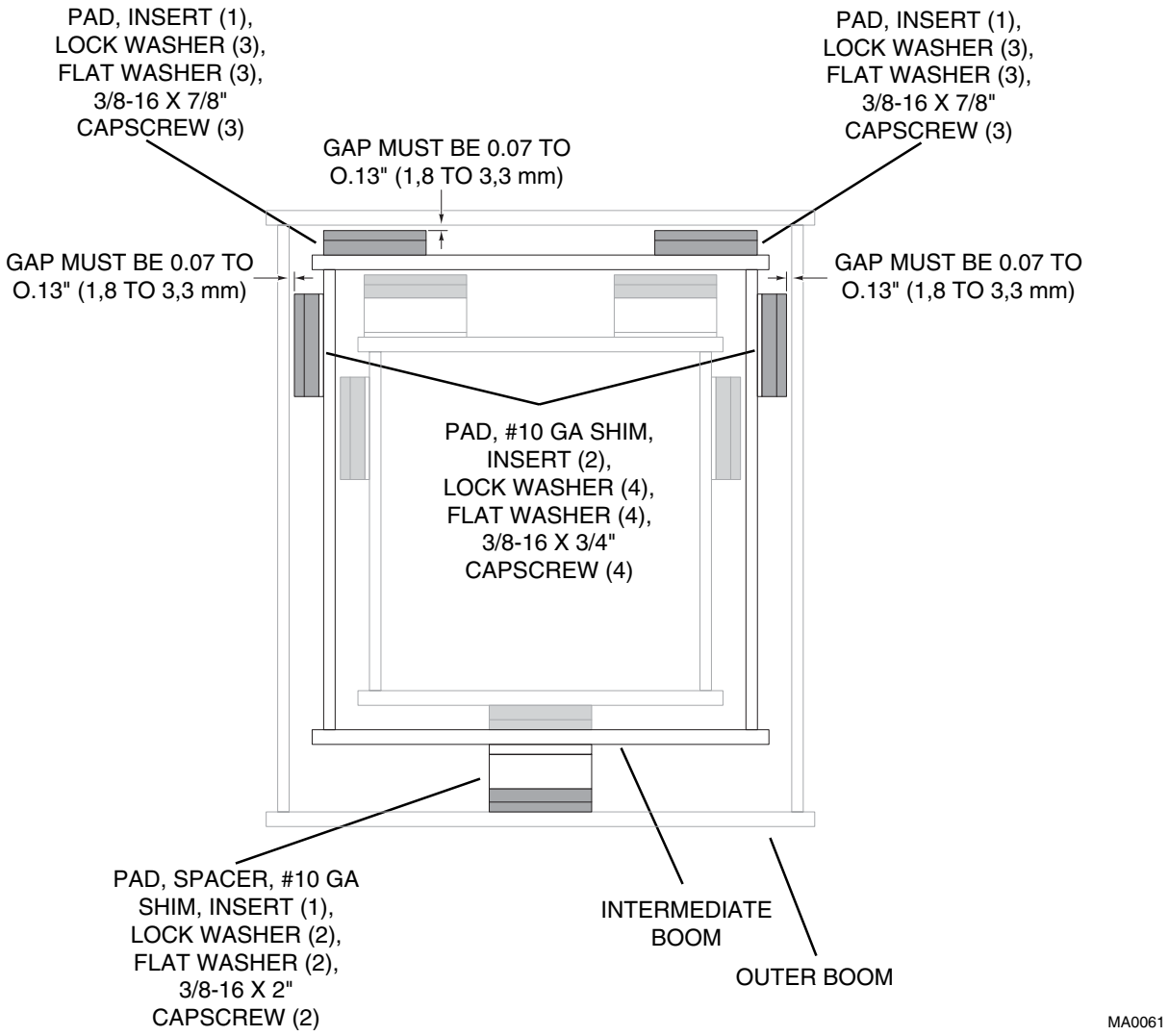


Fig. 3.6 Rear Wear Pads Attached to Intermediate Boom

3.1.3 Outer Boom Replacement

a. Removal

1. Refer to paragraphs 3.1.1.a and 3.1.2.a and remove the inner and intermediate booms.
2. Disconnect and remove the extend and retract chains from the outer boom. Check the condition of the chains and replace if worn or damaged.
3 Refer to paragraph 9.2.2.a and remove the boom extend/retract cylinder.
4. Refer to Fig. 3.7 and remove the locknut and capscrew that secures the slave cylinder rod end pin. Remove the pin. Check the condition of the bearing in the cylinder rod end; replace bearing if worn or damaged.
5. Refer to Fig. 3.8 and disconnect the grille tilt cylinder hoses from the tubing at the hose guides and remove the hoses from the boom.

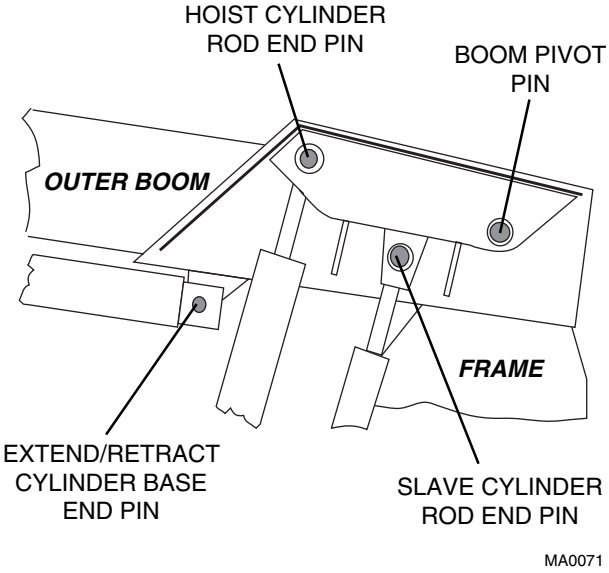


Fig. 3.7 Outer Boom Pivot Pins

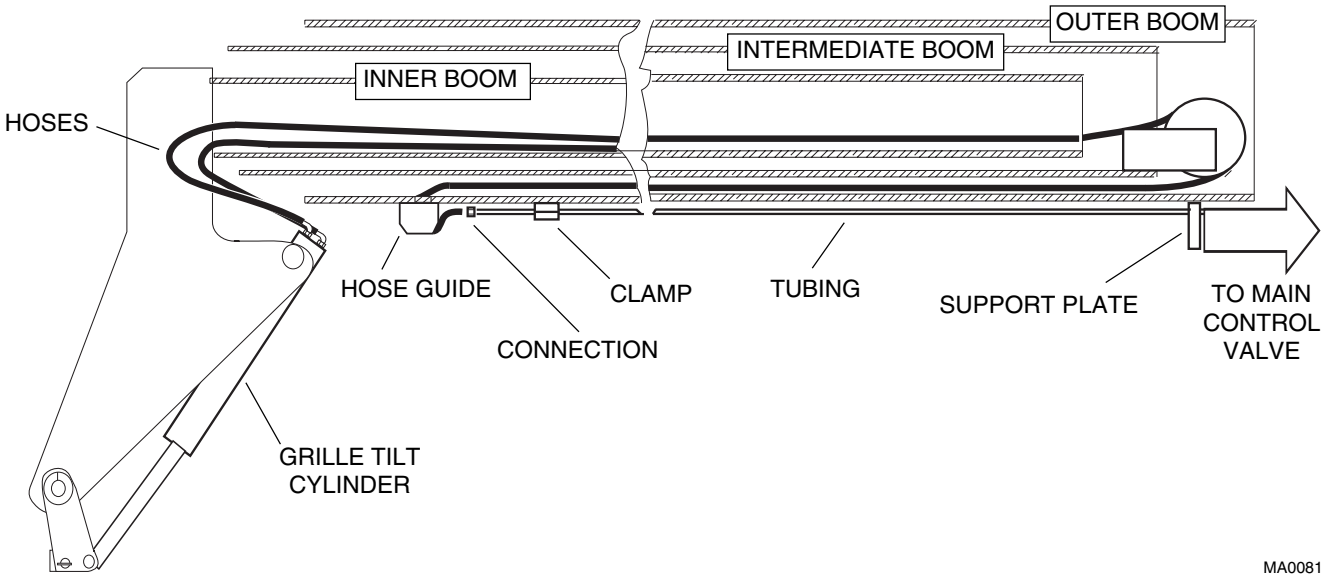


Fig. 3.8 Grille Tilt Cylinder Hoses

6. Disconnect and cap or plug the grille tilt cylinder tubing, extend cylinder tubes and bulkhead fittings in support plate, Fig. 3.8, below the rear opening of the boom.
7. Loosen clamps that hold the tubing to the bottom of the outer boom and remove the tubing from the outer boom.
8. Attach slings and a suitable hoist to the approximate center of gravity of the outer boom and remove all slack from hoist cable.

NOTE: The approximate center of gravity of the outer boom will be closer to the rear of the outer boom.

9. Refer to Fig. 3.7 and remove the locknut and capscrew that secures the hoist cylinder rod end pin. Remove the pin. Check the condition of the bearing in the cylinder rod end; replace bearing if worn or damaged.
10. Refer to Fig. 3.7 and remove the capscrews and lock washers securing boom pivot pins to the outer boom.
11. Remove both boom pivot pins and washer spacers from the outer boom and main frame.
12. Using the hoist, remove the outer boom from the main frame of the forklift.
13. Check the condition of both boom pivot main frame bearings; replace if worn or damaged.
14. If the front outer boom wear pads, Fig. 3.9, are excessively worn, temporarily replace them with new pads. Use the same amount of shimming as used when the pads were removed.

IMPORTANT: *The ends of wear pad attaching capscrews must not protrude beyond the wear pad insert; the ends must range from flush to 0.19" (5 mm) recessed in the wear pad insert (refer to Fig. 3.3).*

b. Inspection and Replacement

1. Inspect the boom and welds and contact JLGI if structural damage is detected.
2. Inspect hoses and replace if damaged.
3. Inspect and replace wear pads as described in paragraph 3.1.8.

c. Installation

1. Using slings and a suitable hoist, align the outer boom pivot collars with the main frame bearings.
2. Install the boom pivot pins and washer spacers, placing the spacers on the inside of the frame bearing, Fig. 3.10. Using No. 10 and/or 14 gauge shims, shim to maintain a gap between the frame bearing and outer boom of 0.07 to 0.13" (1,8 to 3,3 mm).

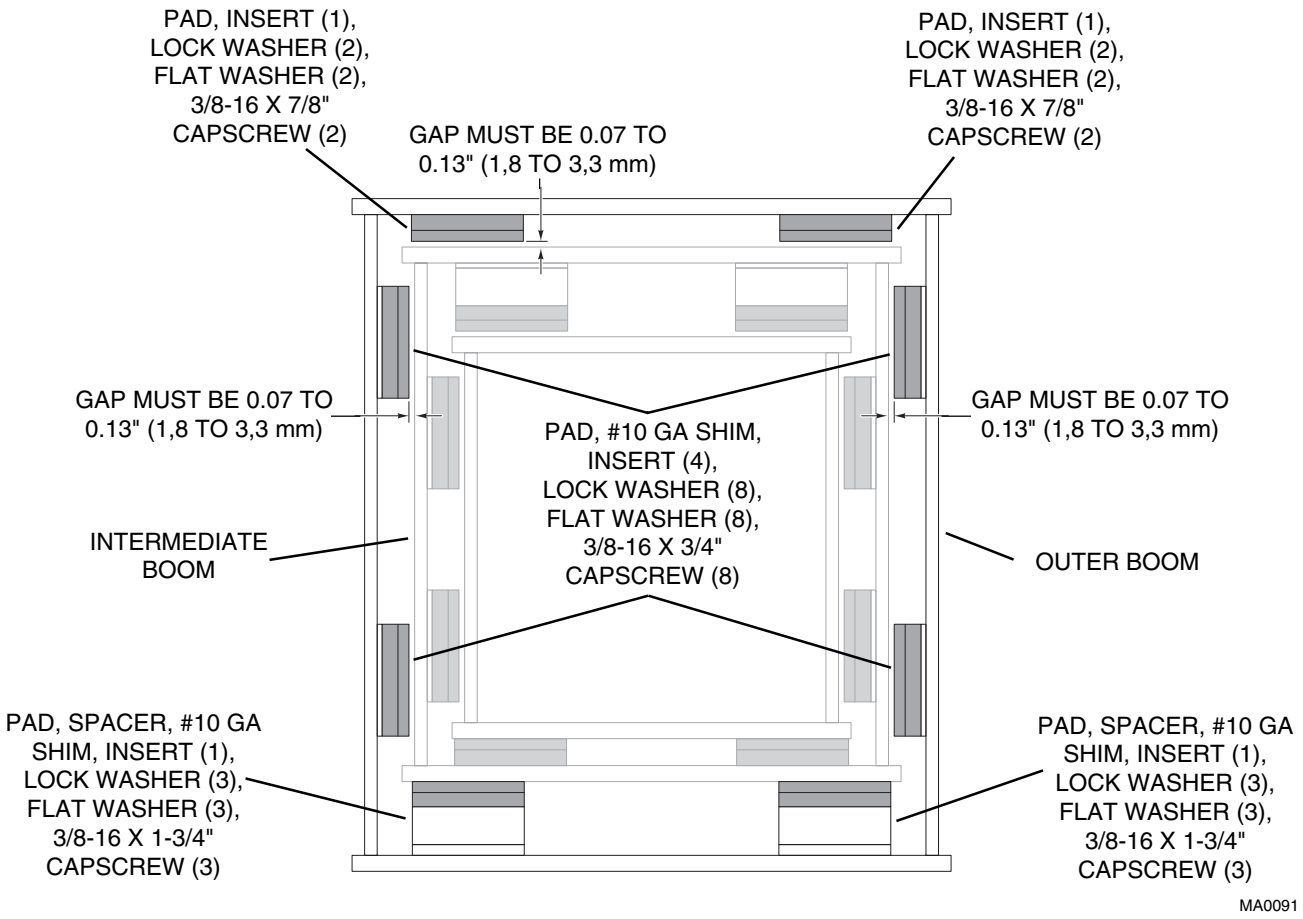


Fig. 3.9 Front Wear Pads Attached to Outer Boom (Rear Wear Pads are Attached to Intermediate Boom)

3. Install the capscrews and lock washers locking the boom pivot pins to the outer boom.
4. Rest the front of the boom on cribbing so it is not solely supported by the hoist.
5. Install the grille tilt cylinder tubing in clamps on the bottom of the outer boom, (Fig. 3.8), and connect each tube, extend tubes and bulkhead fittings to fittings at the support plate. Connect main valve hoses. Tighten the tube clamps.
6. Refer to Fig. 3.8 and connect the grille tilt cylinder hoses to the tubing. Route the hoses around hose guide bracket and into the outer boom. Continue pushing the hoses until they come out the rear boom cover opening.
7. Install the base end of the boom extend/retract cylinder on the outer boom with a pivot pin, Fig. 3.7, and retaining rings. Coat the pin with anti-seize compound.
8. Reattach tubes to extend cylinder ports.
9. Attach the rod end of the slave cylinder to the outer boom with a pivot pin and lock the pin in place with a capscrew and locknut.
10. Attach the rod end of each hoist cylinder to the outer boom with a pivot pin and lock the pin in place with a capscrew and locknut.

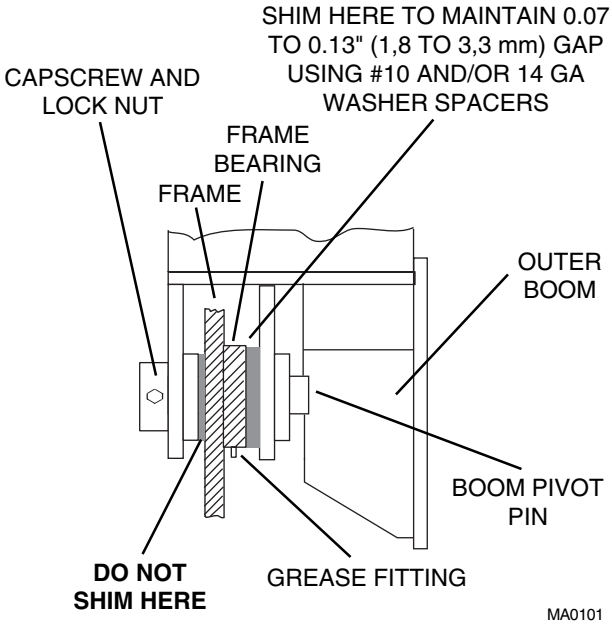


Fig. 3.10 Boom Pivot Pin Shimming

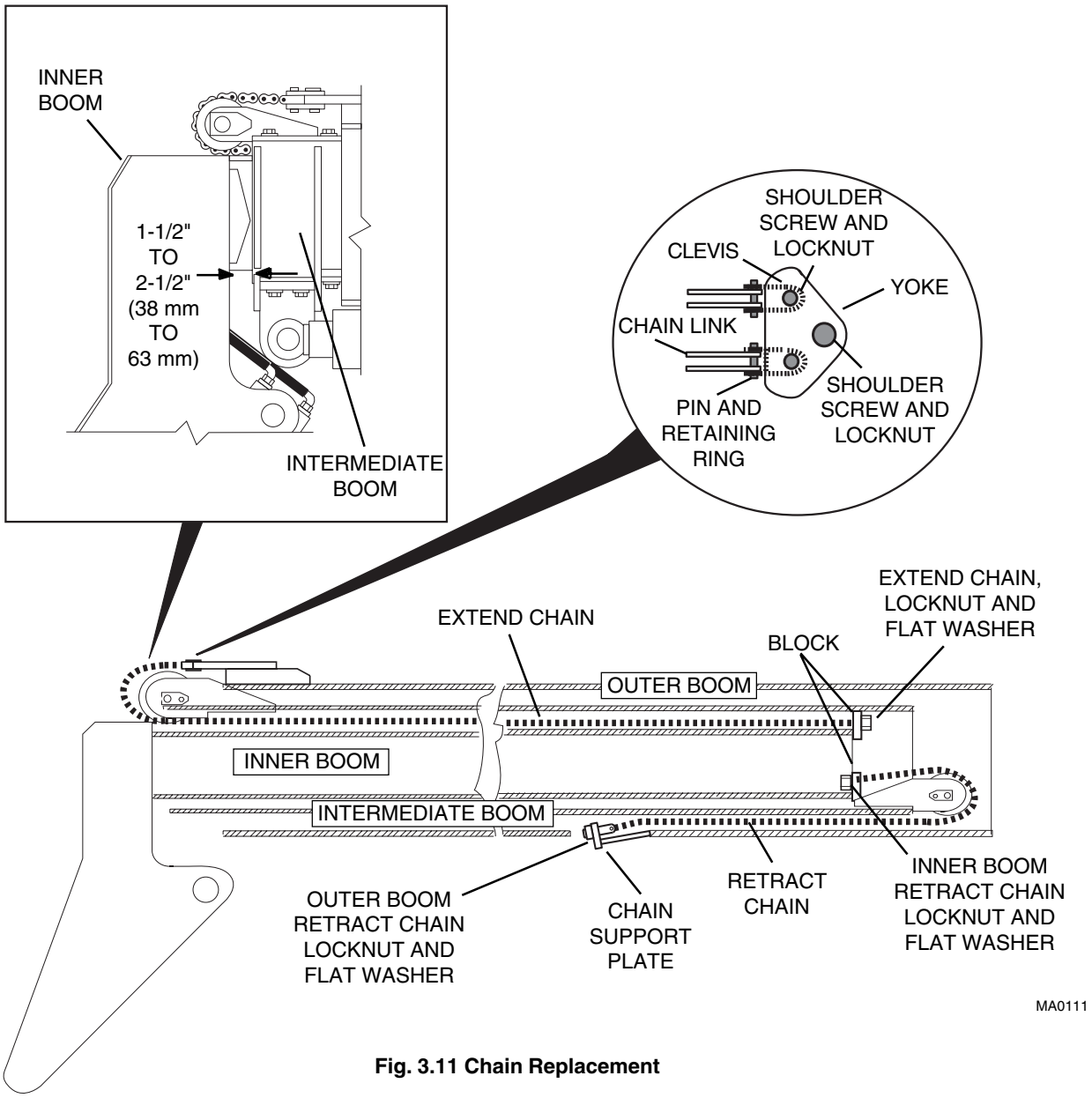


Fig. 3.11 Chain Replacement

11. Attach the two extend chains at the chain yoke, Fig. 3.11, on top of the boom. Allow the remaining ends of the chains to hang free until the intermediate boom has been installed.
12. Attach the retract chain at the chain support plate, Fig. 3.11, and route it along the bottom of the outer boom to the rear boom cover opening.
13. Remove hoist and sling from outer boom.
14. Remove cribbing from front of boom.
15. Refer to paragraphs 3.1.2.b and 3.1.1.b and install the intermediate and inner booms.
16. Refer to Fig. 3.9 and check the wear pad gap between the front outer boom side and top wear pads and the intermediate boom. The gap should be 0.07 to 0.13" (1,8 to 3,3 mm) and equal on all sides. Remove or install shims as required.

IMPORTANT: *The ends of wear pad attaching capscrews must not protrude beyond the wear pad insert; the ends must range from flush to 0.19" (5 mm) recessed in the wear pad insert (refer to Fig. 3.3).*

17. Install the wear pads by applying Loctite 242 to the capscrews and torquing them to 31 lb-ft (42 N m).
18. Lubricate the outer boom pivot pins, Fig. 3.7, with multi-purpose lithium based grease.

3.1.4 Chain Replacement

Two chains extend the inner boom and one chain retracts it.

Extend Chains

IMPORTANT: *Replace extend chains in pairs or sets ONLY.*

a. Removal

1. Fully retract the boom.
2. Remove the rear boom cover.
3. Refer to Fig. 3.11 and remove the extend chain locknut and flat washer securing each chain clevis to a block at the upper rear of the inner boom.
4. Remove the locknut and shoulder screw that attaches each extend chain to the yoke at the front of the boom.
5. Pull the chains out the front of the boom.
6. Remove a chain clevis at both ends of each chain.

b. Installation

1. Be sure the boom is fully retracted.
2. Install a chain clevis on both ends of each chain.
3. Working from the rear boom cover opening, remove both top intermediate boom wear pads to gain access to rear boom chain connection.
4. Using a long rod or other suitable tool, route the chains between the upper plates of the inner and intermediate booms to the front boom opening. Make sure chains are not twisted.
5. Route the chains over the chain sheave and attach the chains to the front yoke with a shoulder screw and locknut. Tighten the locknut completely, then back off 1/4 turn.
6. Secure the rear of the chain to a block at the upper rear of the inner boom with a flat washer and locknut. The elastic collar on the locknut must engage the chain clevis by at least one full thread. Be sure locknuts are tightened equally.
7. Check the position of the chain yoke at the front of the outer boom. The front of the yoke must be parallel to the front face of the outer boom. If not, adjust the locknuts accordingly.
8. Refer to paragraph 3.1.5 and lubricate the chain.
9. Refer to paragraphs 3.1.6 and 3.1.7 and check and adjust the chains.

Retract Chain

a. Removal

1. Fully retract the boom.
2. Remove the rear boom cover.
3. Remove the inner boom retract chain locknut and flat washer, Fig. 3.11, securing the retract chain to a block at the lower rear of the inner boom.
4. Remove the outer boom retract chain locknut and flat washer attaching the retract chain clevis to a chain support plate at the bottom of the outer boom.
5. From the rear outer boom cover opening, pull the retract chain from the space between the outer and intermediate booms.
6. Remove a chain clevis from each end of the chain.

b. Installation

1. Be sure the boom is fully retracted.
2. Install a chain clevis on each end of the chain.
3. Secure the rear of the chain to a block at the lower rear of the inner boom with a flat washer and locknut. Route the chain around the chain sheave. The elastic collar on the locknut must engage the chain clevis by at least one full thread.
4. Using a long rod or other suitable tool, route the chain between the lower plates of the outer and intermediate booms to the chain support plate opening, Fig. 3.11, on the bottom of the outer boom.
5. Secure chain clevis to the chain support plate using a flat washer and locknut. Torque the locknuts to 35 to 40 lb-ft (47,5 to 54,2 N m).
6. Refer to paragraph 3.1.5 and lubricate the chain.
7. Refer to paragraphs 3.1.6 and 3.1.7 and check and adjust the chain.

3.1.5 Chain Lubrication

250 Hour Intervals

1. Remove the rear boom cover from the outer boom.
2. Extend and retract the boom several times applying multi-purpose lithium based grease to the entire retract chain with a brush or grease gun.
3. With the boom fully extended, apply multi-purpose lithium based grease to the extend chain using a brush or grease gun.
4. Install the rear boom cover on the outer boom.

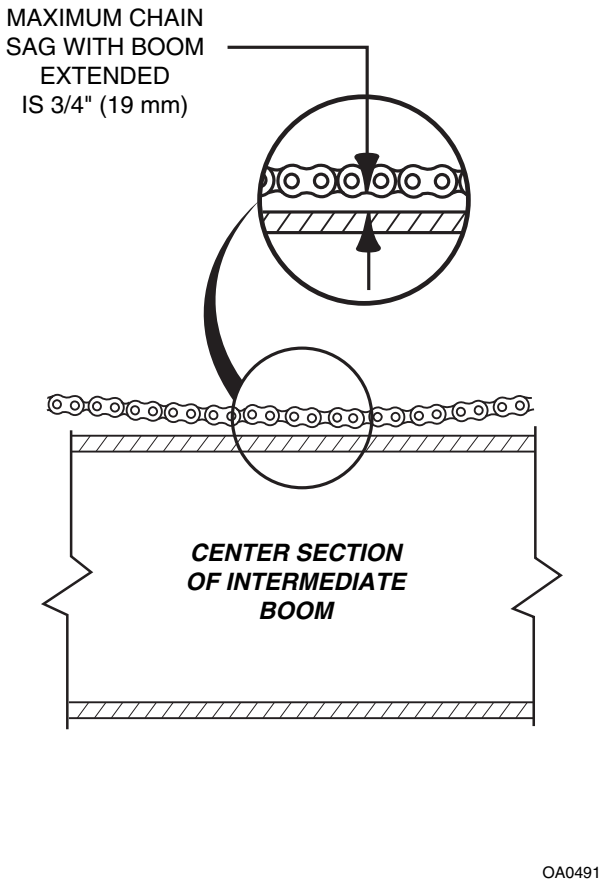


Fig. 3.12 Maximum Extend Chain Sag

3.1.6 Chain Tension Check

250 Hour Intervals

Check tension of boom extend chains after the first 50 hours of operation and at 250 hour intervals thereafter.

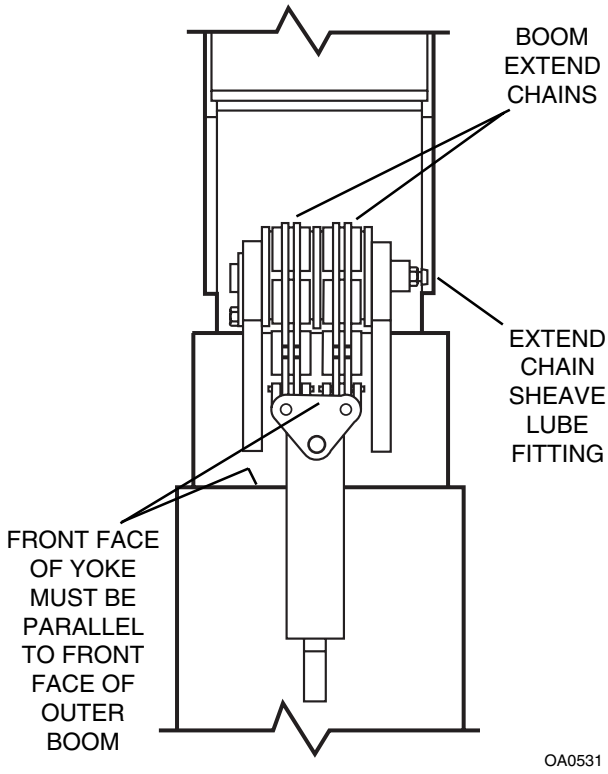

BOOM EXTEND CHAINS
EXTEND CHAIN SHEAVE LUBE FITTING
FRONT FACE OF YOKE MUST BE PARALLEL TO FRONT FACE OF OUTER BOOM
OA0531

Fig. 3.13 Yoke and Extend Chains

Adjust the chains so that:

- the inner boom extends 1-1/2 to 2-1/2" (38 to 64 mm) from the front of the intermediate boom when the boom is retracted, Fig. 3.11, and
- the extend chains are no closer to the intermediate boom than 3/4" (19 mm) when the boom is extended, Fig. 3.12, and
- the front face of the yoke, Fig. 3.13, is parallel to the front face of the outer boom.

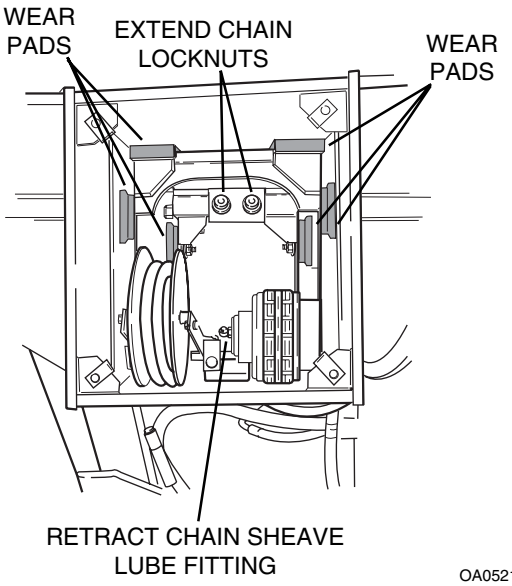


Fig. 3.14 Rear Boom Cover Opening

Adjustment is accomplished using extend chain adjustment locknuts, Fig. 3.14.

a. Chain Locknut Functions

Loosen extend chain locknuts to extend the inner boom and increase extend chain sag.

Tighten outer boom retract chain locknut to retract the inner boom and decrease extend chain sag.

b. Adjusting Procedure

1. Raise the boom to a horizontal (level) position. Fully extend the boom, then retract it 2" which is 1" per section (51 mm which is 25,5 mm per section).
2. Measure sag in the extend boom chains between the bottom of the chains and the top of the inner boom at their closest point, Fig. 3.12. Acceptable boom extend chain sag is between 3/4 and 1-3/4" (19 and 45 mm). If the measurement is less than 3/4" (19 mm), adjust the boom chains as described in the following steps.

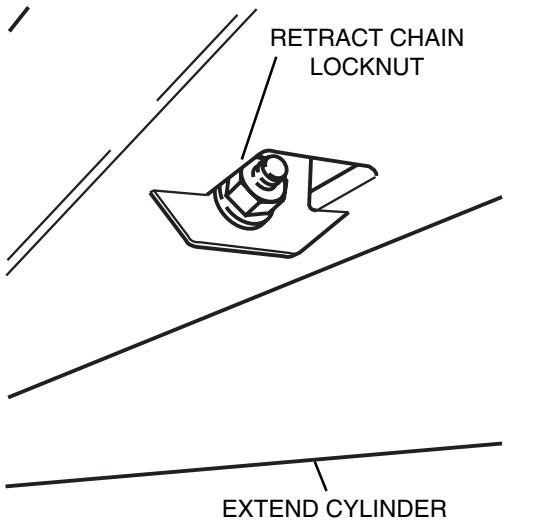


Fig. 3.15 Retract Chain Adjustment Locknut

3.1.7 Chain Tension Adjustment

1. Retract the boom completely to check the position of the inner boom. If the distance between the front edges of the intermediate and inner booms is between 1-1/2 and 2-1/2" (38 and 64 mm) and the extend chain is no closer than 3/4" (19 mm) from the inner boom, proceed no further, the boom chains are adjusted correctly.
2. If the distance between the front edges of the intermediate and inner booms is 2" or more but less than 2-1/2" (51 mm or more but less than 63 mm):
   (a) Tighten the locknut, Fig. 3.15, on the bottom of the outer boom. This retracts the inner boom and takes up the sag in the extend chains.
   (b) Cycle the boom in and out; then, with the boom horizontal (level), fully extend the boom and retract it 2" which is 1" per section (51 mm which is 25,5 mm per section).
   (c) Measure the chain sag, Fig. 3.12. Acceptable boom extend chain sag is between 3/4 and 1-3/4" (19 and 45 mm). If the chain sag is less than 3/4" (19 mm) repeat steps (a) through (c).
3. If the distance measured in Step 1 is less than 2" but greater than 1-1/2" (less than 51 mm but greater than 38 mm):
   (a) Remove the rear cover from the outer boom and adjust the top extend boom chains.
   (b) Tighten the locknuts, Fig. 3.14, for each chain. Be sure each locknut is tightened equally so that chain maintains the same tension. Equal chain tension can be checked by observing the position of the yoke on the outer boom, Fig. 3.13. The front of the yoke should be parallel with the front edge of the boom.
   (c) Cycle the boom in and out; then, with the boom horizontal (level), fully extend the boom and retract it 2" which is 1" per section (51 mm which is 25,5 mm per section).
   (d) Measure the chain sag. Acceptable boom chain sag is between 3/4 and 1-3/4" (19 and 45 mm). If chain sag is less than 3/4" (19 mm), repeat steps (a) through (d).
   (e) Replace the rear cover of the outer boom.

3.1.8 Wear Pad Replacement

After the first 50 hours of operation or when severe wear is suspected

There are 26 wear pads (Fig's 3.3, 3.5, 3.6 and 3.8) between the outer, intermediate, and inner booms. Five are attached to the inner boom, thirteen to the intermediate boom, and eight to the outer. Four additional wear pads may be used in severe twist applications.

The wear pads and wear pads with spacers are shimmed to maintain a gap between the wear pads and the booms of 0.07 to 0.13" (1,8 to 3,3 mm).

IMPORTANT: *Inspect the pads as follows:*

- *Replace wear pads that are less than 0.5" (13 mm) thick.*
- *The ends of wear pad attaching capscrews must not protrude beyond the wear pad insert; the ends must range from flush to 0.19" (5 mm) recessed in the wear pad insert; refer to Fig. 3.3.*
- *When you install a wear pad on one side (including top or bottom) of boom, replace the corresponding wear pad on the other side of the boom. Usually shimming will remain the same when installing new wear pads on corresponding sides of the boom.*
- *Apply Loctite® 242 to all wear pad screws and torque them to 28 to 34 lb-ft (38 to 46 N m).*

a. Inner Boom Wear Pads (Fig. 3.3)

1. All inner boom wear pads can be removed by working through the rear boom cover opening.
2. The bottom pad may be removed by first removing the top pads. Use a wooden wedge between the inner and intermediate boom to provide clearance for removing the bottom pad.
3. Inspect the wear pads removed as described in the preceding ***IMPORTANT*** notice.

b. Intermediate Boom Wear Pads (Fig. 3.5 and 3.6)

1. The rear wear pads can be removed by working through the rear boom cover opening.
2. The rear bottom pad may be removed by first removing the top pads, by using a wooden wedge between the inner and intermediate boom, thereby providing clearance for removing the bottom pad.
3. Front pads can be removed at the front of the boom.
4. The front bottom pad may be removed by first removing the top pads. Lower the gooseneck end of the inner boom to the ground until the intermediate boom raises up to provide clearance for removing the bottom pad.
5. Inspect the wear pads removed as described in the preceding ***IMPORTANT*** notice.

c. Outer Boom Wear Pads (Fig. 3.9)

1. All outer wear pads can be removed working at the front of the boom.
2. The front bottom pad may be removed by first removing the top pads. Lower the gooseneck end of the inner boom to the ground until the intermediate boom raises up, thereby providing clearance for removing the bottom pad.
3. Inspect the wear pads removed as described in the preceding ***IMPORTANT*** notice.

3.1.9 Hose Tensioning

100 Hour Intervals

Adjust grille tilt cylinder hose or auxiliary hydraulic hose tension whenever the boom is disassembled, a hose is changed, or whenever proper hose adjustment is in question. Check hose tension as part of general maintenance every 100 hours.

IMPORTANT: *Before you begin tensioning the hoses make sure that the hoses are not twisted within the boom. Keep the hose manufacturers marking in line as a guide.*

1. Park forklift on level surface, engage park lock and fully retract and level the boom.
2. Remove the rear boom cover, Fig. 3.1.
3. If the vehicle has auxilliary hydraulics there will be four hoses in hose clamps, Fig. 3.16b, with the auxilliary hose clamps stacked on top of the grille tilt cylinder hose clamps, Fig. 3.16a. Remove the capscrews and hose clamps, holding upper hoses in place, Fig. 3.16b, and move aside to gain access to the lower capscrews and hose clamps.

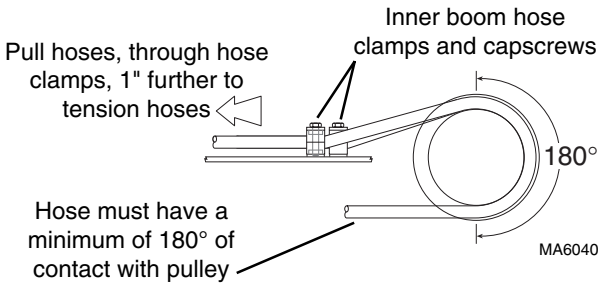
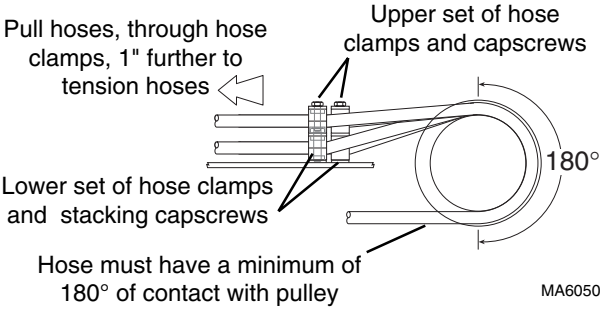

Inner boom hose clamps and capscrews
Pull hoses, through hose clamps, 1" further to tension hoses
180°
Hose must have a minimum of 180° of contact with pulley
MA6040

Fig. 3.16a Cylinder Hose Tensioning


Upper set of hose clamps and capscrews
Pull hoses, through hose clamps, 1" further to tension hoses
180°
Lower set of hose clamps and stacking capscrews
Hose must have a minimum of 180° of contact with pulley
MA6050

When vehicle has auxilliary hydraulics option, remove upper clamps in stack and tension lower hoses first and then tension top hoses

Fig. 3.16b Cylinder Hose Tensioning

4. Loosen capscrews securing the hose clamps to the inner boom, Fig. 3.16a or Fig. 3.16b.
5. Manually remove all hose slack between the pulley and the inner boom hose clamps and the pulley and the outer boom tubes. Pull the hoses through the hose clamps, towards the front of the boom, until there is 180° of hose in contact with the pulley.
6. Pull the hoses 1" further into the hose clamps so the hose achieves more than 180° of contact with the pulley and at the same time tighten the clamp capscrews.
7. If the vehicle has auxilliary hydraulics, replace the upper hoses and clamps onto the lower hose clamps. Do not fully tighten the cap-screws. Repeat steps 4 through 6 for the upper hoses and clamps.
8. Replace the rear boom cover.

3.1.10 Long Term Storage Preparation

Remove rust and corrosion from sliding surfaces and coat with grease.

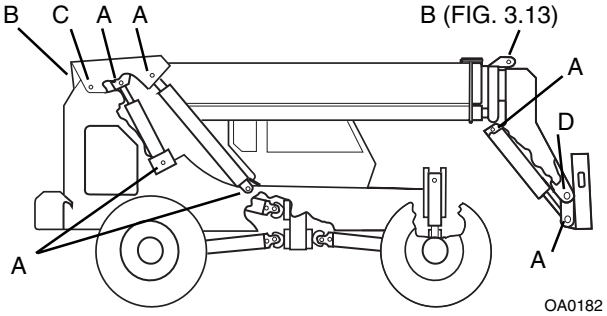


Fig. 3.17 Forklift Lubrication Points

3.1.11 Boom Lubrication Points

Lubricate the following grease fittings using Multi-Purpose Grease (MPG) **every 50 hour interval**. Refer to Fig. 3.17.

A. Hydraulic cylinder pins (8 points)

B. Boom chain sheaves (2 points)

C. Boom pivot pins (2 points)

D. Carriage pivot pin (2 points)

Lubricate the boom extend and retract chains using Multi-Purpose Grease (MPG) **every 250 hour interval.**

1. Prepare to grease the chains by removing the rear cover from the outer boom.
2. Apply MPG to retract chain using a brush or grease gun.
3. Extend and retract the boom several times to permit grease to penetrate the entire chain.

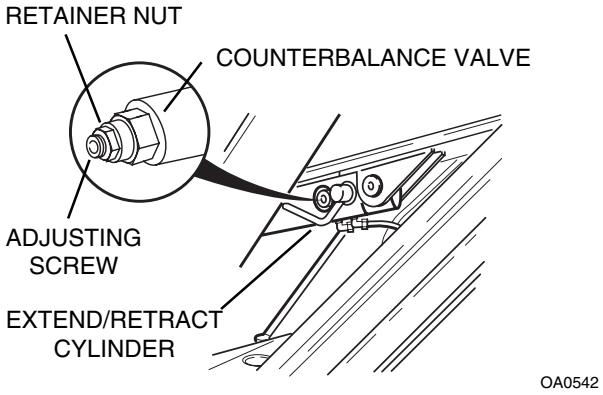


Fig. 3.18 Counterbalance Valve on Boom Extend/ Retract Cylinder

4. With the boom extended fully, apply MPG to the extend chain using a brush or grease gun.
5. Replace the rear outer boom cover.

3.2 EMERGENCY BOOM LOWERING

3.2.1 Loss of Engine Power or Hydraulic Pump Failure

If you lose engine power or hydraulics with an elevated boom, lower the boom to the ground by using the following procedure:

Warning !

DO NOT get under a raised boom unless the boom is blocked up. Always block the boom before doing any servicing which requires the boom to be up.

IMPORTANT: *If the boom has been extended, you must first retract the boom before you attempt to lower the boom.*

To retract the boom proceed as follows:

1. Block the boom so it cannot be lowered.
2. At the base end of the extend/retract cylinder, locate the counterbalance valve cartridge, Fig. 3.18. Loosen the retainer nut and turn the adjusting screw in (clockwise) until it bottoms out. Doing this will render the counterbalance valve inoperative.
3. Clear the area around the machine of all personnel and return to the operators cab.
4. Move the boom control lever to the left and retract the boom.

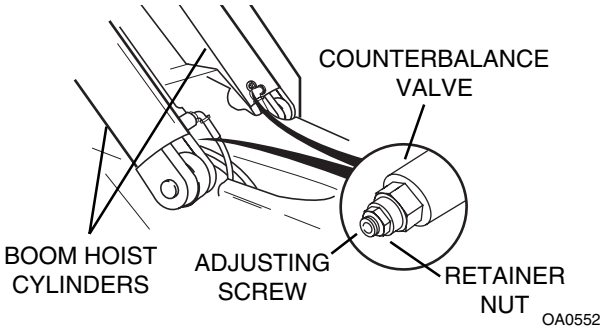


Fig. 3.19 Counterbalance Valves on Boom Hoist Cylinders

After the boom has been retracted fully, proceed as follows:

1. At the base of each hoist cylinder, locate the counterbalance valve cartridges, Fig. 3.19. Loosen the retainer nut on each cartridge and turn the adjusting screws in (clockwise) until they bottom out. Doing this will render each counterbalance valve inoperative.
2. Remove the blocking that is supporting the boom.
3. Clear the area around the machine of all personnel and return to the operators cab.
4. Move the boom control lever forward to lower the boom.

IMPORTANT: *This procedure is to be used in emergency situations only. By turning the counterbalance cartridge adjusting screws to make the valve inoperative, the pressure settings of the cartridge have been altered.* ***DO NOT*** *attempt to reset these cartridges. Remove and replace all three cartridges with new parts. Failure to replace these cartridges with new parts will result in erratic (extreme bouncing) lowering action, which may cause damage to other components.*

3.2.2 Hydraulic Line Failure

Warning !

In the event of a hydraulic line failure in any of the boom control circuits, extreme CAUTION must be taken when attempting to lower an elevated load. Hydraulic oil under high pressure will escape through the fault in the line which may result in the boom retracting or lowering at a rapid rate. DO NOT perform this procedure unless you are absolutely sure of what you are doing. Consult your local JLG Distributor or the JLG Service Department before proceeding.

IMPORTANT: *If the boom has been extended, you must first retract the boom before you attempt to lower the boom.*

1. Block the boom so it cannot be lowered.
2. If the line failure is isolated to the hoist circuitry only, boom retraction can be performed by operating the boom control lever in the normal fashion.
3. If the line failure is in the boom extend line the boom must be retracted by following the next step:
   (a) At the base of the extend/retract cylinder, locate the counterbalance valve cartridge, Fig. 3.18. Loosen the retainer nut and control the rate of retraction by turning the adjusting screw into the cartridge **very slowly** clockwise. Hydraulic oil from inside the extend/retract cylinder will escape through the fault in the line.
4. If the line failure is in the boom retract line the boom must be retracted by following the next 3 steps:
   (a) At the base of the extend/retract cylinder, locate the counterbalance valve cartridge Fig. 3.19. Loosen the retainer nut and turn the adjusting screw in (clockwise) until it bottoms out. Doing this will render the counterbalance valve inoperative.
   (b) Clear the area around the machine of all personnel and return to the operators cab.
   (c) Move the boom control lever to the left to retract the boom.
5. If the line failure was isolated to the extend/retract circuit only, the boom can now be lowered by operating the boom control lever in the normal fashion after the blocking is removed.

After the boom has been retracted fully, proceed as follows:

1. Remove the blocking that is supporting the boom.
2. If the line failure is in the boom hoist line the boom must be lowered by following the next step.
   (a) Using two people to perform this procedure will make boom lowering much easier. At the base end of each hoist cylinder, locate the counterbalance valve cartridges, Fig. 3-19. Loosen the retainer nut and control the rate of boom lowering by turning the

adjusting screw on each cartridge simultaneously into the cartridge **very slowly** clockwise. Hydraulic oil from inside the hoist cylinders will escape through the fault in the line.

3. If the line failure is in the boom lowering line the boom must be lowered by following the next 3 steps:
   (a) At the base of each hoist cylinder, locate the counterbalance valve cartridges, Fig. 3-19. Loosen the retainer nut on each cartridge and turn the adjusting screws in (clockwise) until they bottom out. Doing this will render each counterbalance valve inoperative.
   (b) Clear the area around the machine of all personnel and return to the operators cab.
   (c) Move the boom control lever forward to lower the boom.

IMPORTANT: *This procedure is to be used in emergency situations only. By turning the counterbalance cartridge adjusting screws to lower the boom, the pressure settings of the cartridge have been altered.* ***DO NOT*** *attempt to reset these cartridges. Remove and replace all three cartridges with new parts. Failure to replace these cartridges with new parts will result in erratic (extreme bouncing) lowering action, which may cause damage to other components.*

3.3 QUICK ATTACH ASSEMBLY

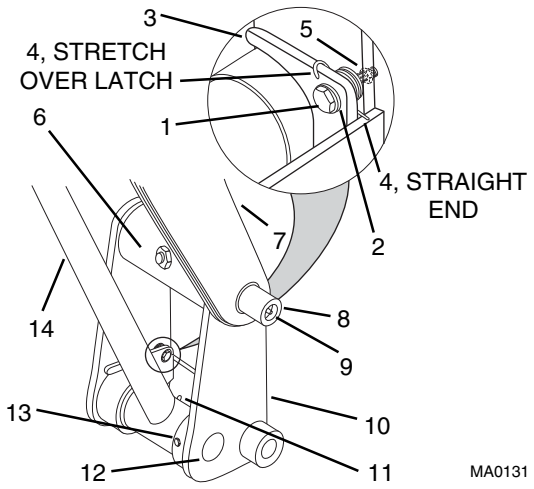
The quick attach assembly, Fig. 3.20, provides a structure on which an attachment may be installed or removed from the forklift.

a. Removal

1. Fully lower boom and ground the attachment.
2. Remove the attachment from the quick attach.
3. Remove capscrew and locknut (13, Fig. 3.20) locking grille tilt cylinder rod end pin (12) in the quick attach.
4. Tap the grille tilt cylinder rod end pin from the quick attach.
5 Remove capscrew and locknut (6) locking quick attach pin (8) in the quick attach.
6. Tap the quick attach pin from the quick attach.
7. Remove quick attach assembly (10) from gooseneck (7).
8. Remove the latch assembly capscrew (1), flat washer (2), locknut (5), spring (4), spacer, and latch (3) if any replacement is necessary.

b. Installation

1. If the latch assembly was removed, install it as follows:
   (a) Assemble flat washer (2, Fig. 3.20), latch (3), spacer, and spring (4) on the capscrew.
   (b) Install capscrew (1) on the quick attach making sure the straight end of the spring rides on the top edge of the weldment plate.
   (c) Install, snug and then back off locknut (5) as required to permit free rotation of latch (3).
   (d) Stretch the spring hook over the latch.
2. Install quick attach assembly (10) on gooseneck (7) with quick attach pin (8). Lock the pin in place with capscrew and locknut (6).
3. Lubricate the pin through grease fittings using a good grade of multi-purpose lithium based grease.
4. Install grille tilt cylinder rod (14) on the quick attach assembly with cylinder rod end pin (12). Lock the pin in place with capscrew and locknut (13).
5. Lubricate the pin through grease fitting using a good grade of multi-purpose lithium based grease.
6. Install the attachment on the quick attach assembly.



1. Capscrew
2. Washer, Flat
3. Latch
4. Spring
5. Locknut
6. Capscrew and Locknut
7. Gooseneck
8. Pin, quick attach
9. Fitting, grease (both ends)
10. Quick Attach Assembly
11. Fitting, grease
12. Pin, grille cylinder
13. Capscrew and Locknut
14. Rod, grille tilt cylinder

Fig. 3.20 Quick Attach Assembly

3.4 TROUBLESHOOTING

Trouble	Probable Cause	Remedy	Reference
Fails to Extend or Retract	Broken hydraulic line and/or connection leaks.	Locate break and/or stop leaks.	
	Faulty Extend/Retract Cylinder.	Repair Cylinder.	Section 9
	Faulty components in Extend/ Retract hydraulic circuitry.	Troubleshoot components and repair or replace components.	Section 9
	Broken chains or chain connections.	Repair or replace chains.	See para. 3.1.4
Fails to Raise or Lower	Broken Hydraulic line and/or connection leaks.	Locate break and/or stop leaks.	
	Faulty Hoist Cylinder(s).	Repair Cylinder(s).	Section 9
	Faulty components in Raise/Lower hydraulic cir-cuitry.	Troubleshoot components and repair or replace.	Section 9
Excessive Boom Pivot Pin or Cylinder Pivot Pin Wear	Improper grease intervals.	Replace worn pins and lubricate at regular intervals.	See para. 3.1.11
	Worn bearings.	Replace bearings and lubricate at regular intervals.	Section 9
Excessive Wear Pad Wear	Improper wear pad shimming.	Check shim adjustment and shim properly.	See para. 3.1.8
	Contaminated, corroded or rusted wear pad sliding surfaces (due to improper preparation for long term storage).	Prep boom properly for long term storage.	See para. 3.1.10
Drooping Chain or Jerky Boom Extend or Retract Functions	Chains out of adjustment.	Readjust chains.	See para. 3.1.7
Grille Tilt or Auxiliary Hydraulic Circuit Line Failures	Improper hose tension or hose sheave misaligned.	Reset hose sheave tension.	See para. 3.1.9
Excessive Chain Wear	Chain out of adjustment.	Replace and readjust chains properly.	See para. 3.1.4 & 3.1.6
	Improper chain lubrication.	Replace chain(s) and lubricate at regular intervals.	See para. 3.1.4 & 3.1.5

3.5 SPECIFICATIONS

	For 13.00-24 10 ply Tires	For 15,00-19.5 12 ply Tires
Maximum lift height - boom extended	36 ft. 1 in. (11 m)	35 ft. 5 in. (10,8 m)
Maximum lift height - boom retracted	20 ft. 1 in. (6,1 m)	19 ft. 3 in. (11,7 m)
Maximum below grade depth - boom extended	39.5 in. (100,3 cm)	40.5 in. (102,9 cm)
Maximum reach from front of tire	22 ft. 5 in. (6,8 m)	22 ft. 10 in. (7,0 m)
Maximum reach at maximum lift angle - boom extended	45.0 in. (114,3 cm)	50.5 in. (128,3 cm)
Reach at maximum lift angle - boom retracted	-26.0 in. (-66,0 cm)	-19.6 in. (-49,8 cm)
Maximum reach at minimum boom angle - boom extended	21 ft. 2.5 in. (6,5 m)	21 ft. 8.25 in. (6,6 m)
Maximum boom lift angle	71 degrees -9 degrees	71 degrees -9 degrees
Fork tilt angle at:		
Minimum boom angle up	11 degrees	11 degrees
Minimum boom angle down	101 degrees	101 degrees
Maximum boom angle up	87 degrees	87 degrees
Maximum boom angle down	25 degrees	25 degrees

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SECTION 4
OPERATOR'S CAB

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4.1 SEAT

The seat, Fig. 4.1, is mounted on an adjustable suspension unit. The seat assembly consists of a seat cushion and two slides. One of the slides has a forward/backward adjustment lever. A seat belt is attached to the seat.

a. Adjustment

You can adjust the seat for your weight and height and position it horizontally and vertically.

Position the seat for your height by simply pulling up on the seat until the desired level (low, middle, or high) is attained. To return the seat to the low level, raise the seat past the high level and allow it to return to the low level.

Adjust the seat to your weight by turning a suspension adjust knob on the front of the suspension unit until you see your weight in kilograms (2.2 pounds per kilogram) on an indicator next to the knob.

Adjust the horizontal or forward/backward position of the seat by using the forward/backward lever on the slide to the left of the seat.

b. Seat Removal

The seat and seat slides may be removed from the suspension unit and mounting plate by removing four locknuts and flat washers that attach the seat slides to the suspension unit.

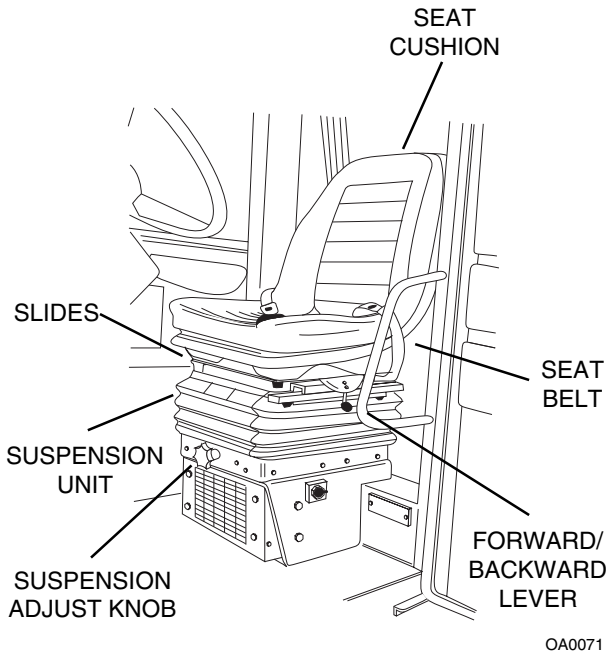

Fig. 4.1 Seat

4.2 MECHANICAL HAND CONTROLS

Mechanical hand controls in the operators cab are shown in Fig. 4.2.

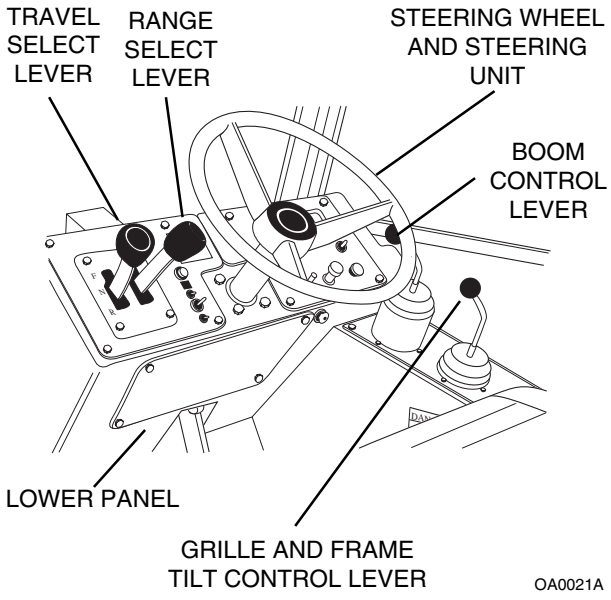

Fig. 4.2 Mechanical Hand Controls

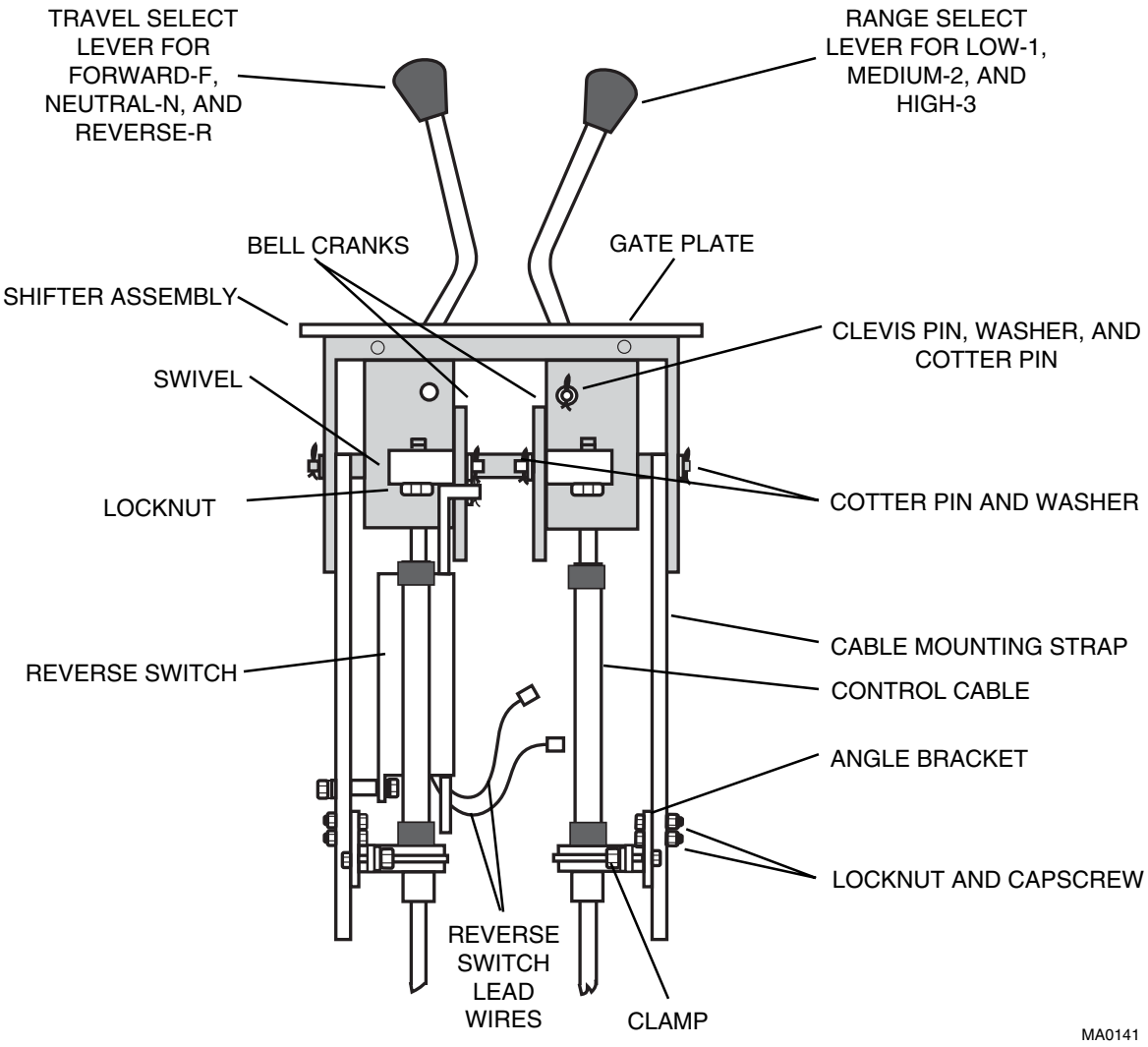

Fig. 4.3 Shifter Assembly

4.2.1 Steering Wheel and Steering Unit

The steering wheel changes the direction of forklift travel in two-wheel, four-wheel, or crab steering modes as designated by the steering select switch. Refer to your Owners/Operators Manual for a description of these steering modes.

The wheel is attached to the steering unit with a nut that must be torqued to 50 lb-ft (68 N m). The steering unit is attached to the control console with four flange-head screws and lock washers.

4.2.2 Travel Select and Range Select Levers

Use the travel select lever to place transmission in Forward-F, Neutral-N, and Reverse-R and the range select lever to select Low-1, Medium-2, and High-3 gears.

The levers are mounted in a transmission shifter assembly, Fig. 4.3. A cable attached to each lever terminates at a linkage which moves a spool in the transmission control valve.

a. Transmission Shifter

Removal

1. Remove lower panel, Fig. 4.2, below the control console.
2. Remove the clamps that secure the control cables to the angle brackets.
3. Remove the cotter pins and washers that attach the swivels to the bellcranks. Label and remove the cables from the shifter assembly, Fig. 4.3. Remove the swivel from the end of each cable by turning it counterclockwise
4. Disconnect the reverse switch red and black lead wires from the wiring harness.
5. Remove the shifter assembly from the control console.

Maintenance

1. Prepare to clean and lubricate the spring, disk and ball in each travel and range select lever mechanism by removing the cotter pins, washers and clevis pins that secure each lever to the shifter assembly. Remove the levers from the shifter assembly.
2. Clean each lever spring, disk, and ball with an approved solvent. Replace defective or damaged parts as required. Apply a multi-purpose grease to each disk, spring, and ball.
3. Install the spring, disk and ball in the shifter assembly.

Installation

1. Install the shifter assembly on the control console.
2. Connect the reverse switch wires to the wire harness by connecting the red switch wire to red harness wire 24 and the black switch wire to yellow harness wire 31.
3. Use washers and cotter pins to connect the specific cable with swivels to the appropriate bellcranks.
4. Secure the control cables to their respective angle brackets with clamps.
5. Install the lower panel on the control console.

b. Transmission Cable

Removal

1. Remove lower panel below control console.
2. Remove the clamp that secures control cable to angle bracket, Fig. 4.3.
3. Remove cotter pin and washer that attach the swivel to the shifter assembly bellcrank and remove the swivel with cable from the lever.
4. Remove the swivel from end of each cable.
5. Remove the transmission cover.
6. Remove the cotter pin and washer, Fig. 4.4, that attach the cable connecting the swivel to the bellcrank and remove the swivel with cable from the bellcrank.
7. Remove the swivel from the cable by turning it counterclockwise.

Installation

1. Thread jam nut and swivel on rod end as shown and connect swivel to bellcrank using a washer and a cotter pin, Fig. 4.4.
2. Tighten jam nut.
3. Place travel and range select levers in their middle positions—N and 2.
4. With transmission spools in center position, install clamp into groove on cable and secure clamp to bracket.

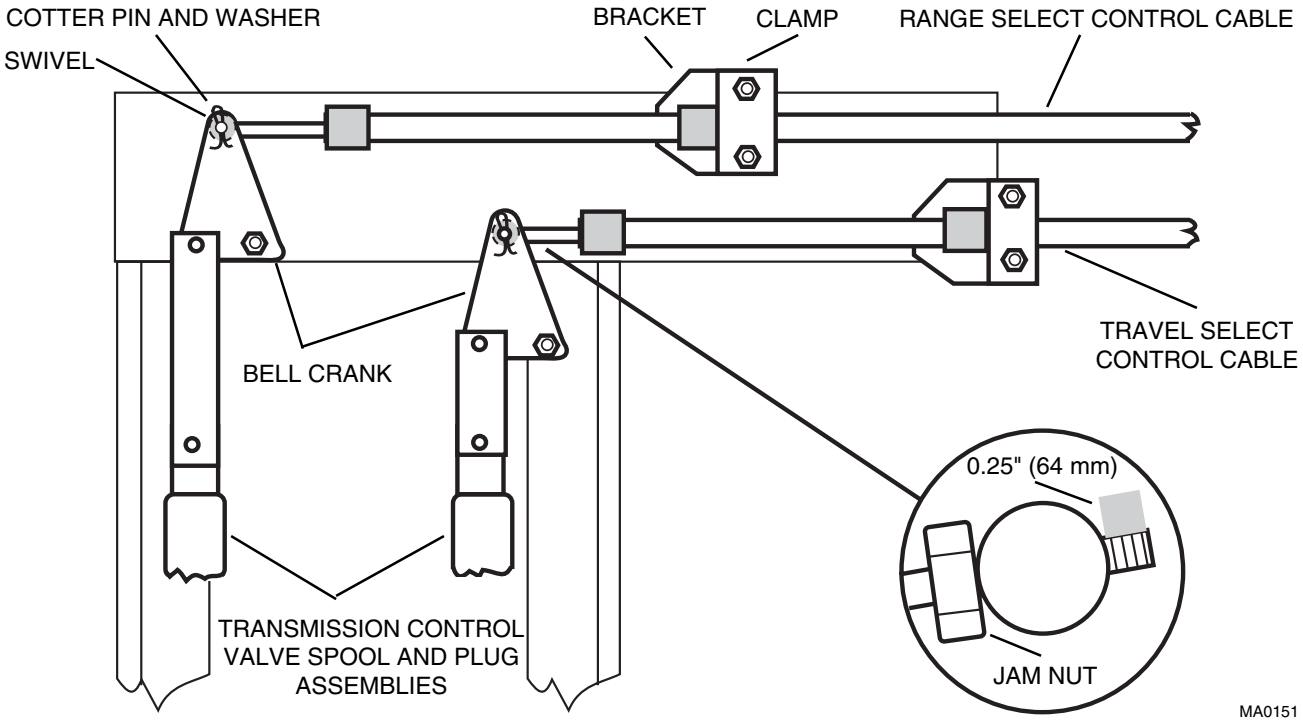

Fig. 4.4 Transmission Control Valve Cable

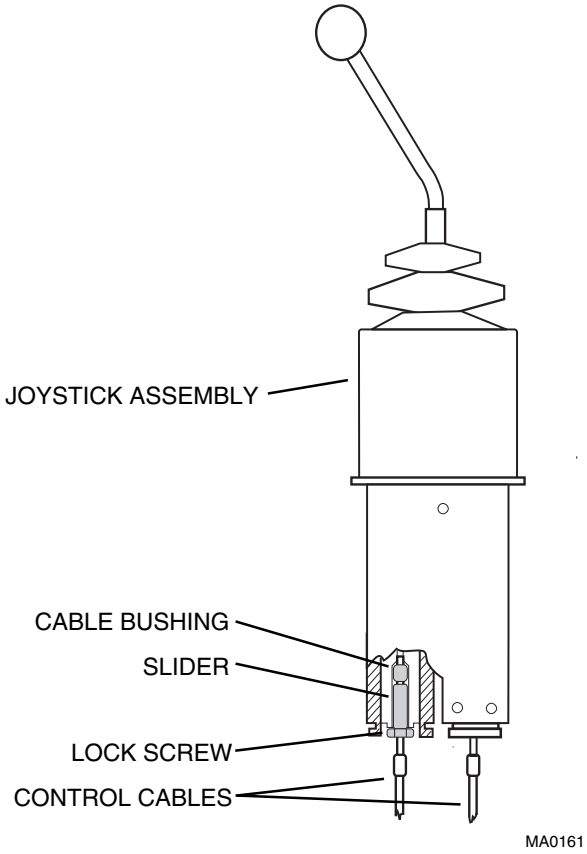

Fig. 4.5 Joystick Assembly With Covers Removed

5. Assemble the other end of each cable, Fig. 4.3, by installing the swivel on the cable by turning it clockwise. Position each swivel so it lines up with the hole in each bellcrank.
6. Install the swivel by using a washer and a cotter pin.
7. Clamp the cable to the angle bracket.
8. Install the transmission cover and lower panel.

4.2.3 Boom Control and Grille and Frame Tilt Joysticks

The Boom Control Joystick raises, lowers, retracts, and extends the boom. The Grille / Frame Tilt Joystick tips the carriage up or down and tilts the frame left or right. See the Owners/Operators Manual for operational descriptions.

A control cable attached to each joystick assembly, Fig. 4.5, terminates at a valve section on the main control valve, Fig. 4.6.

a. Joystick Assembly

Removal

1. Remove the lower panel which is located below the side console.
2. Remove the covers from the joystick assembly, Fig. 4.5.
3. Loosen the lock screws until the control cables, with lock screws and cable bushings, can be removed from the sliders.
4. Remove the joystick assembly from the side console panel.

Installation

1. Install joystick assembly in side console panel.
2. Install the control cables in the sliders.
3. Tighten the slider lock screws holding the sliders in position with a 5/8 inch open-end wrench.

IMPORTANT: *Do not exceed 55 lb-ft (75 N m); DO NOT let slider rotate during this step. It could damage other internal parts of the joystick.*

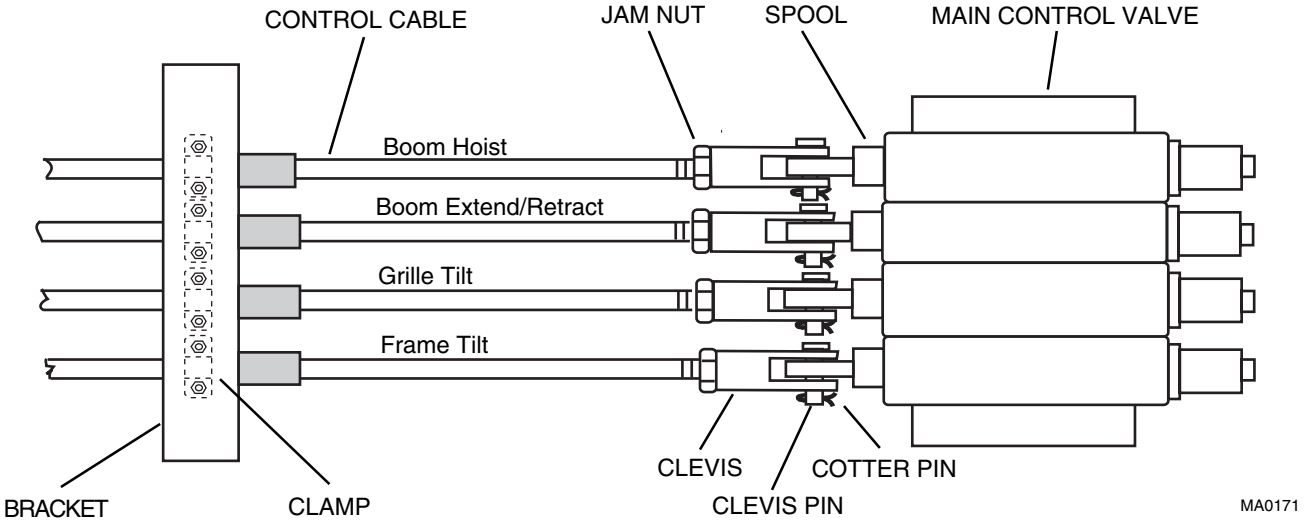

Fig. 4.6 Boom Control and Grille and Frame Tilt Control Lever Connections

4. Install the covers on the joystick assembly.
5. Install the lower panel.

b. Joystick Control Cables

Removal

1. Remove the lower panel which is below the side console.
2. Remove the covers from the joystick assembly, Fig. 4.5.
3. Loosen the lock screw until the control cable, with lock screw and cable bushing, can be removed from the slider.
4. Unthread cable bushing from cable and remove lock screw from cable.
5. Remove the transmission cover.
6. Remove the clamp, Fig. 4.6, that secures the control cable to the bracket on the forklift frame.
7. Remove the cotter and clevis pin that attaches the control cable to the spool on the main control valve.
8. Remove the clevis and jam nut from cable end.
9. Remove the cable from the forklift.

Installation

1. Route the control cable between the joystick and the main control valve.
2. Secure the cable to the main control valve spool, Fig. 4.6, with clevis and cotter pins.
3. At the other end of the cable, slip the lock screw over the cable rod end.
4. Thread the cable bushing onto the cable rod end and position it as shown in Fig. 4.5.
5. Insert the cable into the control slider. Then thread the lock screw into the slider
6. Use a 5/8 inch open end wrench to hold the slider in position and tighten the slider lock screw; work carefully so you don't rotate the slider.

IMPORTANT: *Do not exceed 55 lb-ft (75 N m).*

7. Adjust the cable at both ends so that it operates properly.
8. Replace the covers on the joystick assembly.
9. Install the lower panel below the side console.
10. Install the transmission cover.

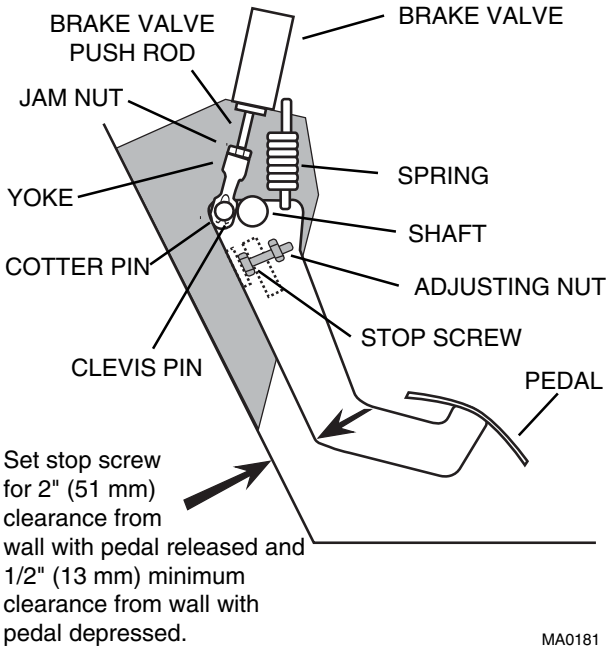

Fig. 4.7 Service Brake Pedal

4.3 MECHANICAL FOOT CONTROLS

4.3.1 Service Brake Pedal

When you press the service brake pedal you activate a brake valve that applies the hydraulic service brakes. The service brake pedal pivots on a shaft and is held in the raised position by a spring.

a. Removal

1. Remove the lower panel below the control console.
2. Remove the cotter pins and clevis, Fig. 4.7, that secures the brake valve yoke to the brake pedal.

NOTE: Brake valve push rod will slip out of brake valve at this point. Remove push rod with yoke attached.

3. Remove the spring from the pedal.
4. Remove one capscrew, washer and nut that attaches pedal shaft to mounting frame. Slide shaft out of pedal and remove pedal and flat washers.

b. Installation

1. Lubricate the shaft, Fig. 4.7, with multi-purpose lithium-based grease. Install shaft through mounting frame, flat washer, pedal, flat washer and mounting frame. Secure in place with capscrew and nut.

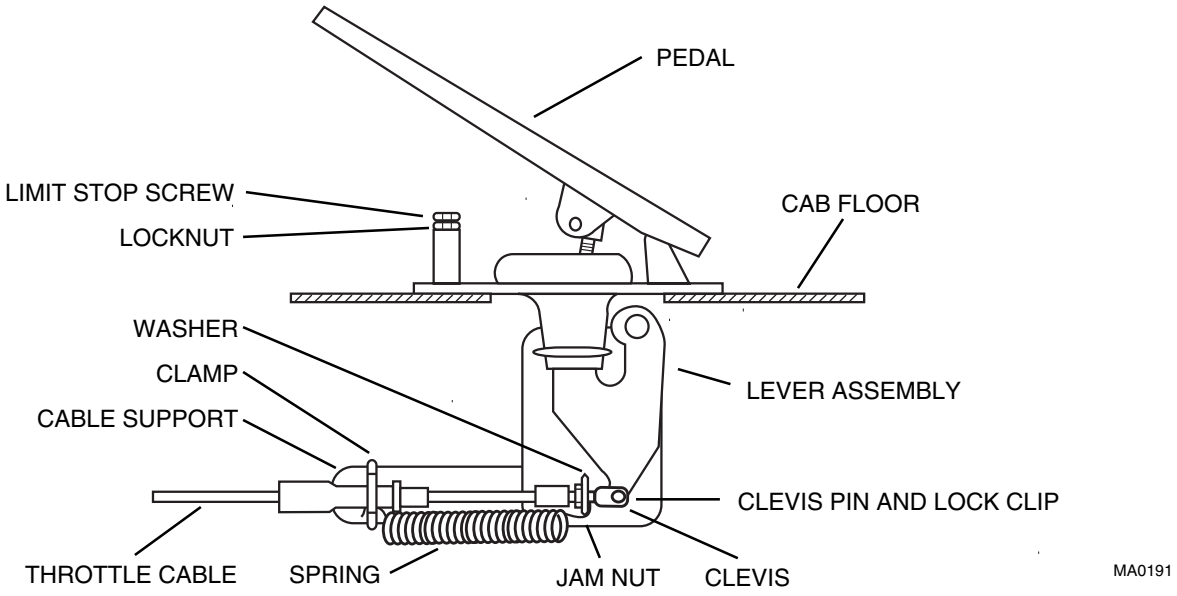

Fig. 4.8 Throttle Pedal

2. Install the spring on the pedal and hook the other end over the support inside the console.
3. Slide push rod into brake valve and secure the yoke to the pedal with clevis and cotter pins.
4. Check the brake valve capscrews to be sure they are torqued to 30 lb-ft (40,8 N m).
5. Adjust the pedal as described in paragraph c.
6. Install the lower panel below the control console.

c. Adjustment

1. Remove the lower panel below the control console.
2. Fully depress the brake pedal and set push rod for 1/2" (13 mm) minimum clearance under pedal arm as shown in Fig. 4.7.
3. Release brake pedal and adjust the adjusting nut, Fig. 4.7, so the pedal is 2" (51 mm) from the front cab wall. Depress the pedal. It must not contact the cab wall.
4. Adjust push rod so it does not depress brake valve piston completely. There must be 1/2" (13 mm) clearance between the end of the rod and the piston. Tighten the rod jam nut to 30 lb-ft (40,8 N m) when adjustments are complete.

4.3.2 Throttle Pedal and Cable

The throttle or accelerator pedal increases engine rpm. A throttle cable connects it to a throttle and stop lever on the engine fuel pump, Fig. 4.9. A spring returns it to the raised position.

a. Throttle Pedal Assembly

Removal

1. Working beneath the operator's cab, remove the spring, Fig. 4.8, from between the pedal clamp and the clevis.
2. Remove the clevis pin and lock clip attaching the clevis to the throttle lever assembly.
3. Remove the clamp attaching the throttle cable to the cable support.
4. Working from inside the cab, remove the three bolts, lock washers, and nuts attaching the pedal to the cab floor.
5. Remove the pedal from the floor.

Installation

1. Secure the pedal, Fig. 4.8, to the floor with three bolts, lock washers, and nuts.
2. Attach the cable to the support with a clamp.
3. Fasten the clevis to the lever assembly with the clevis pin and lock clip.
4. Hook one end of the spring around the pedal clamp and the other end around the neck of the clevis, Fig. 4.8.
5. Check that all connections are secure.
6. If necessary, adjust the pedal limit stop as follows:

Adjustment

1. Lightly depress the throttle pedal to full position.

2. Adjust the limit stop screw until it touches the pedal.
3. Tighten the locknut to 120 to 125 lb-inch (13,6 to 14,1 N m).
4. Check engine rpm at full throttle. If not 2600 to 2860 rpm, readjust the limit stop screw.

IMPORTANT: *During the full throttle check*

- *operate no hydraulic function,*
- *do not steer, and*
- *be sure the transmission is in neutral.*

b. Throttle Cable

Removal

1. Working beneath the operator's cab, remove the spring, Fig. 4.8, from between the pedal clamp and washer on the clevis.
2. Remove lock clip and clevis pin that attaches the clevis to the throttle lever assembly.
3. Remove the clamp attaching the throttle cable to the cable support. Remove short clevis, washer, and jam nut from the cable end.
4. Open the right side engine access door.
5. Remove the round-head screws attaching the clamp, Fig. 4.9, to the throttle cable bracket. Remove the clamp from the bracket.
6. Remove the cotter pin, clevis pin and two washers attaching the throttle cable clevis to the engine stop and throttle lever, Fig. 4.9.

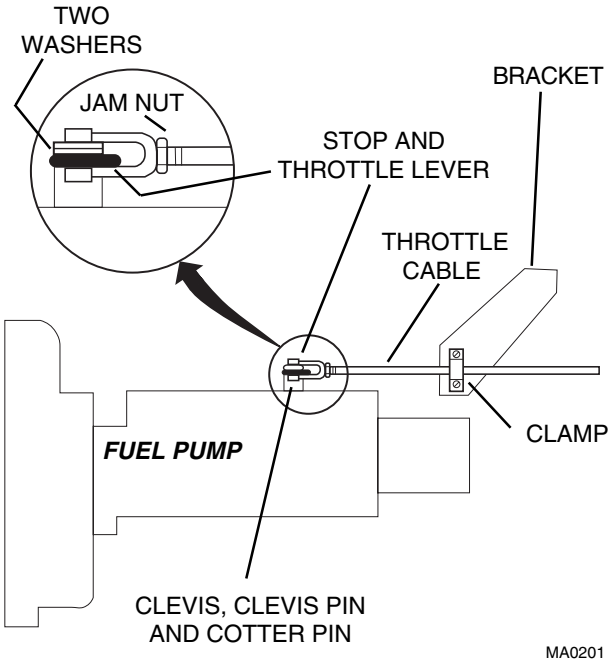

Fig. 4.9 Throttle Cable Engine Connection

7. Remove the long clevis and jam nut from the cable end.
8. Remove the throttle cable from the forklift.

Installation

1. Thread jam nut and long clevis completely onto one end of the cable. Thread a jam nut, washer and short clevis completely on the other end of the cable. Further adjustment on the rod end will be required after the cable is installed.
2. Secure long clevis end of throttle cable to the engine stop and throttle lever, Fig. 4.9, with clevis pin, washers and cotter pin. Be sure both washers are positioned between clevis and above engine stop and throttle lever.
3. Install the cable in the clamp and secure the clamp on the throttle cable bracket with round-head screws.
4. Route cable on forklift to throttle panel under floor of operator cab.
5. Attach the short clevis end of the cable to the support with a clamp, Fig. 4.8.
6. Fasten the short clevis to the lever assembly with a clevis pin and lock clip.
7. Clamp cable to cable support.
8. Hook one end of the spring around the pedal clamp and the other end around the neck of the clevis, Fig. 4.8.
7. Check that all connections are secure.
8. If necessary, adjust the pedal limit stop as described in the following paragraph.
9. Close and lock right side engine access door.

Adjustment

1. Lightly depress the throttle pedal to full position
2. Adjust the limit stop screw until it touches the pedal.
3. Tighten the locknut to 120 to 125 lb-inch (13,6 to 14,1 N m).
4. Check engine rpm at full throttle. If it is not between 2600 and 2860 rpm, readjust the limit stop screw.

IMPORTANT: *During the full throttle check*

- *operate no hydraulic function,*
- *do not steer, and*
- *be sure the transmission is in neutral.*

4.4 REAR VIEW MIRRORS

The forklift has two rear view mirrors.

- A 6-1/2 by 10" flat glass mirror on the cab frame to the left of the operator.
- A 6-1/2 by 6" convex glass mirror on the forklift frame to the right of the operator.

The mirrors have an outer gasket for edge shock protection. If a mirror shatters, a replacement mirror can be installed in the mirror head.

4.4.1 Mirror Head Adjustment

A “preset” locates the “home” position for each mirror. When you swing a mirror outward a detent locks the mirror in your preset viewing position. This reduces the need for frequent mirror adjustment.

You can swing the mirror assembly inboard to reduce overall vehicle width for parking in tight areas; the mirror will also pivot inboard upon impact.

Adjust mirror “preset” as follows:

IMPORTANT: *Before attempting to reposition a mirror on a forklift which has just been received from the factory, loosen the bottom nuts to permit loop and mirror adjustment.*

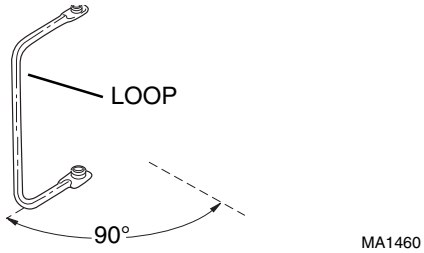

Fig. 4.10 Position Loop 90° from Side of Forklift

1. Position the loops so they extend from the side of the forklift, Fig. 4.10.
2. Adjust mirror heads for proper view. Evaluate view from operator’s seat; change loop angle and readjust each mirror if necessary.

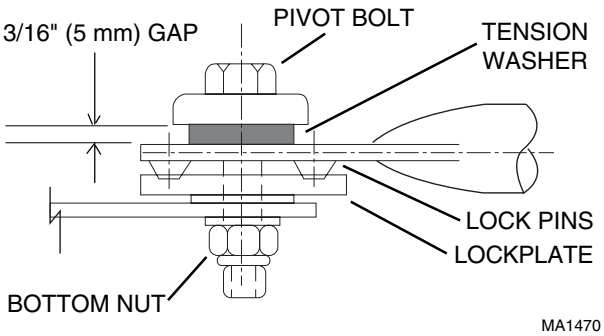

Fig. 4.11 Tighten Pivot Bolt to Provide a 3/16" (5 mm) Gap

3. Tighten “preset” pivot bolt to a 3/16" (5 mm) gap as shown in Fig. 4.11.

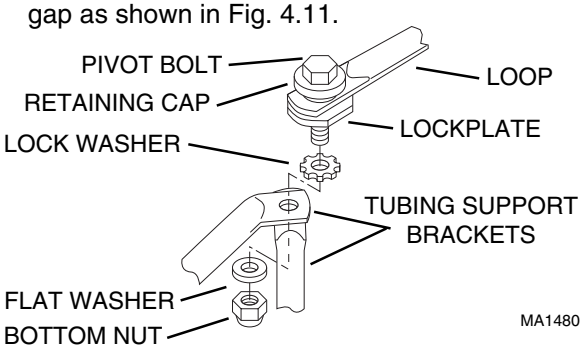

Fig. 4.12 Tighten Bottom Nut While Holding Pivot Bolt Stationary

4. Be sure lock pins are seated in lock plate as shown in Fig. 4.12. Tighten bottom nut while holding pivot bolt stationary. Then torque bottom nut 250 to 300 lb-inch (28 to 34 N m). This will lock the “preset” to its “home” position. The effective torque value for your mirror could vary slightly. The nut must be tight enough to prevent the lock plate from rotating; it must hold the mirror assembly in position under forklift operating conditions and allow the mirror to pivot freely when moved by hand.
5. Check “preset” function by rotating loop back and forth. A definite click will be heard and felt as the loop is rotated past the “home” position.
6. Return loop to “home” position. The loop should snap firmly into place and the lock pins should be firmly located in the holes of the lock plate.

NOTE: Use all weather grease periodically on the lock pins to maintain smooth operation.

4.4.2 Mirror Cleaning and Inspection

1. The mirrors must be properly adjusted. They must be kept free from condensation, frost, ice, snow, dust and dirt. Rinse heavy grit from mirror before you clean it with glass cleaner and dry it with a soft cloth.
2. Be especially careful when removing ice from mirror to avoid breaking or scratching mirror. You can use a nonmetallic scraper, heat or an approved chemical to lower the freezing point of the ice to aid in ice removal.
3. Return each mirror to “home” position after cleaning.
4. Replace mirror glass if broken, damaged or missing (the concave surface of the convex mirror has a 21" radius).
5. Replace mounting hardware if damaged or missing.

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SECTION 5
WHEEL ASSEMBLY, TIRES, AND AXLE

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5.1 WHEEL ASSEMBLY AND TIRE

Warning !

Whenever you remove tire(s) and wheel(s) from forklift:

- Position forklift on a flat, hard surface and support forklift with approved jack stands.
- Use appropriate safety glasses, safety shoes and appropriate clothing and equipment.
- Do not wear rings or jewelry or use clothing or hair styles that could become caught in machinery or pinch points such as those created between tire and hub.
- Allow no one to be under forklift or near drive line when engine is operating or drive line is in motion because clothing and limbs could be caught by and drawn into drive line resulting in serious personal injury or death.
- Deflate tire completely before servicing as specified in paragraph 5.1.1.
- Use specialized tools for mounting and demounting tires. These include 18 and 36 inch bead unseating tools, tire irons, a mallet for unseating beads, a wire brush, a remote control inflation line with clip-on chuck so operator may stand aside during inflation, and an air/water pressure gauge that operator can observe during inflation.
- Use safety cage or enclose tire in safety chains when inflating a newly mounted tire or deflating a tire.
- Inflate tire to manufacturer's recommended cold operating pressure.
- Use only approved tire mounting lubricant; never use antifreeze, silicones or petroleum base lubricants.
- Be sure rim diameter exactly matches rim diameter molded on tire. Clean and inspect rim.
- Inspect inside of tire for dirt, foreign material, loose cords, cuts, penetrating objects, and other carcass damage; discard tires with unreparable damage.

The forklift may have standard or optional wheels and tires.

- Standard 13.00 - 24, 10 ply tires and three piece 8.00 - 24 TGF wheels
- Optional 15.00 x 19.5, 12 ply tires and single piece 12.5 x 19.5 wheels.

The tires are filled with air and hydrofill which is a calcium chloride and water solution. Super large bore TR618A valve stems expedite inflation and deflation or evacuation. A special core housing ejector tool is used for inflating and evacuating. A hose connects the ejector tool to a pump and a barrel or reservoir of the calcium chloride solution, and an air/water pressure gauge.

IMPORTANT: *Mount tire so it will rotate in the direction of arrow on side wall of tire, Fig. 5.1. Position tire on wheel so tire will rotate in direction of arrow. This mounting requirement produces Left Side and Right Side Tire and Wheel Assemblies.*

When filling or evacuating a tire:

- position valve stem at its highest or top position when filling tire;
- position tire with valve stem at its lowest or bottom position when evacuating a tire.

Check tire inflation with valve at the bottom of a hydrofill or liquid filled tire when tire is cold and before forklift is operated. A tire that has sufficient pressure when hot may be underinflated when it cools.

Warning !

- NEVER operate forklift without hydrofill in tires.
- NEVER attempt to unseat the beads of an inflated tire.
- NEVER reinflate a tire that has been run flat or seriously underinflated without removing tire from wheel and checking for tire and rim damage.
- NEVER hit a tire or rim with a hammer or sharp object.
- NEVER rework, weld, heat, or braze a rim.

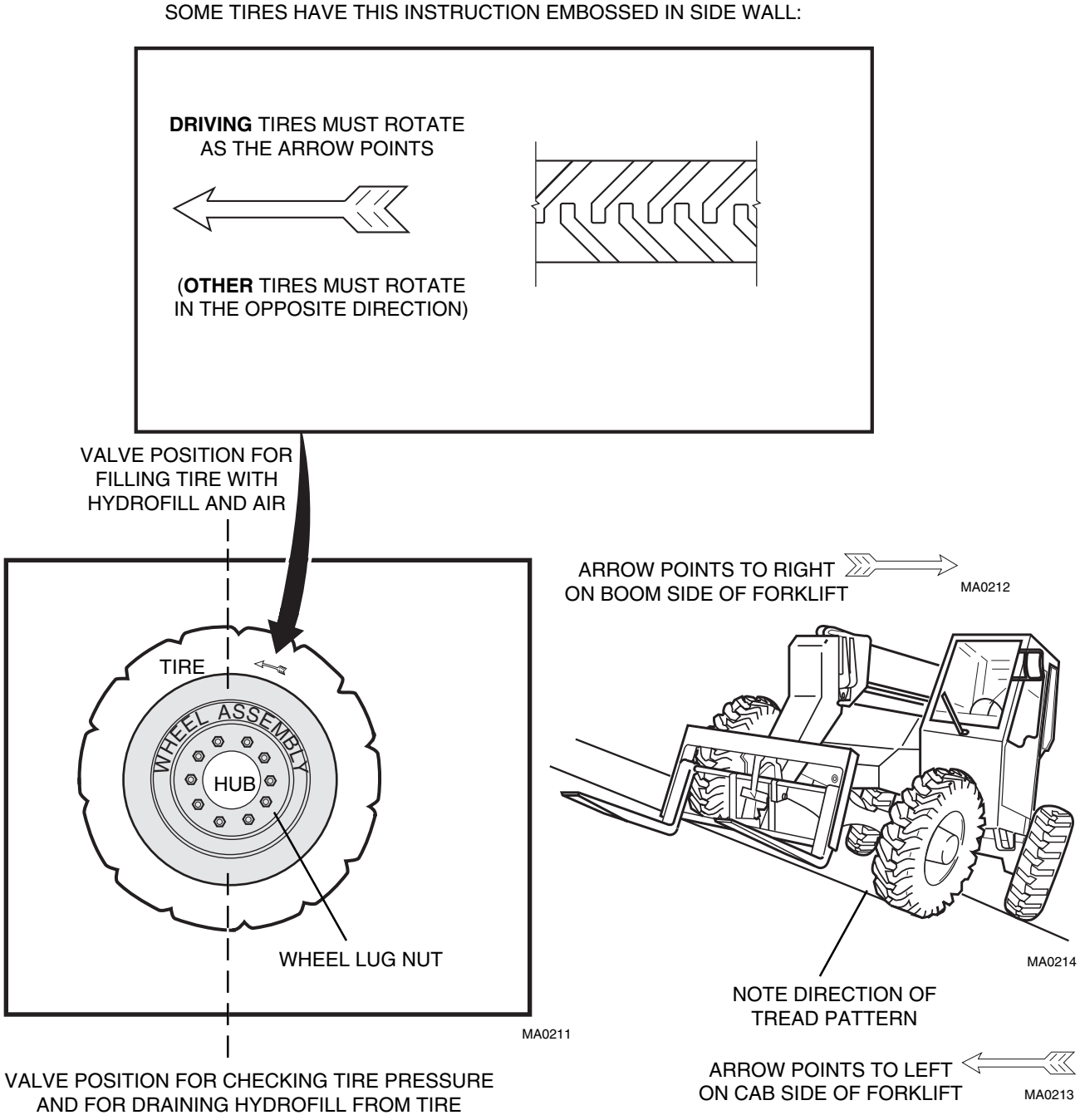

SOME TIRES HAVE THIS INSTRUCTION EMBOSSED IN SIDE WALL:
DRIVING TIRES MUST ROTATE AS THE ARROW POINTS
(**OTHER** TIRES MUST ROTATE IN THE OPPOSITE DIRECTION)
VALVE POSITION FOR FILLING TIRE WITH HYDROFILL AND AIR
TIRE
WHEEL ASSEMBLY
HUB
WHEEL LUG NUT
MA0211
VALVE POSITION FOR CHECKING TIRE PRESSURE AND FOR DRAINING HYDROFILL FROM TIRE
ARROW POINTS TO RIGHT ON BOOM SIDE OF FORKLIFT
MA0212
MA0214
NOTE DIRECTION OF TREAD PATTERN
ARROW POINTS TO LEFT ON CAB SIDE OF FORKLIFT
MA0213

Fig. 5.1 Tire Direction of Rotation and Valve Stem Positions for Tire Pressure Check, Fill and Evacuate

NOTE: The calcium chloride hydrofill solution will corrode a standard tire pressure gauge. Use a corrosion resistant tire pressure gauge . Be sure to flush the gauge with clear water after checking a tire inflated with hydrofill and air.

Before you remove a tire from a wheel, use an ejector tool to remove the valve core and use ejector tool and pump to remove calcium chloride solution from the tire.

These instructions cover tire removal and installation for the standard three piece wheel and for the optional single piece wheel.

Instructions in *italics* refer to a tire with an optional *tube.* You may use a tube if the tire doesn't provide an air tight seal.

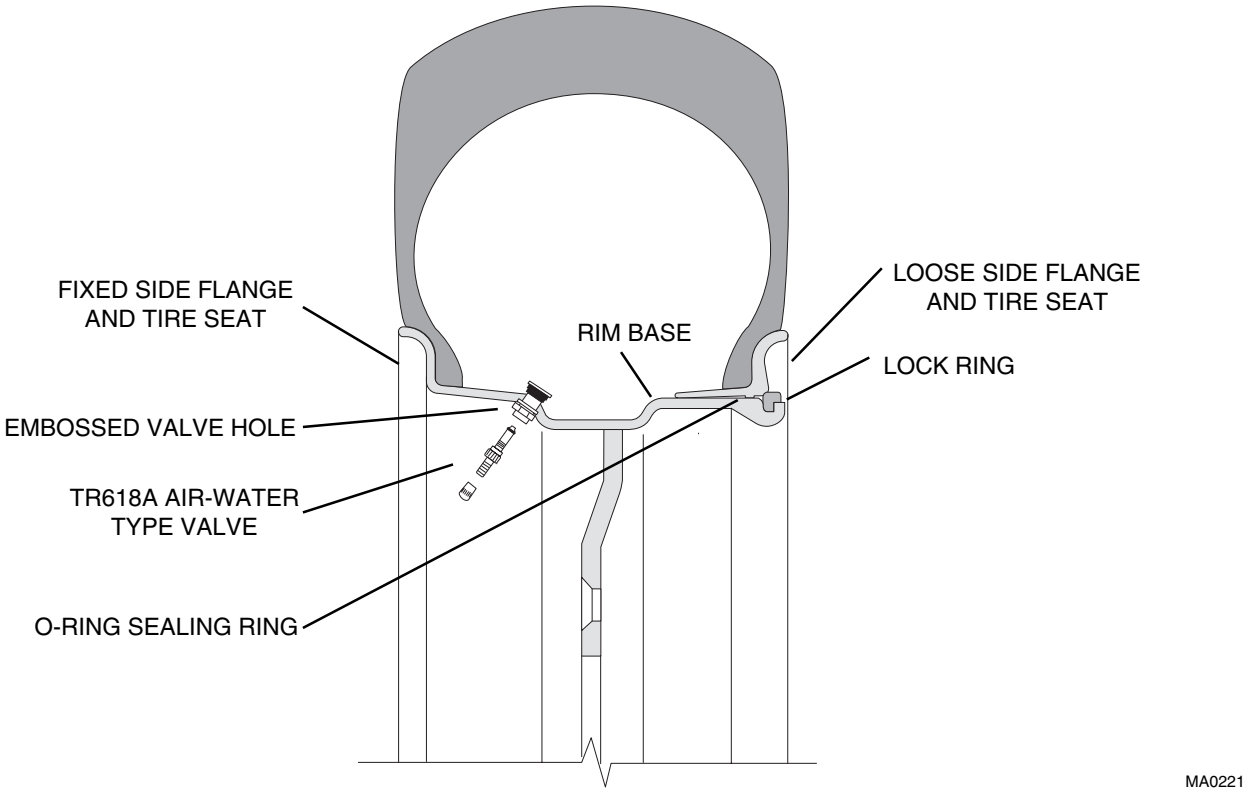


Fig. 5.2 Standard Wheel Assembly with T-Type Rim and Fixed Back Flange

Tire and wheel maintenance is covered in the following paragraphs:

5.1.1 Removing Hydrofill from Tire or Tube within Tire
5.1.2 Demounting Tire
5.1.3 Removing Wheel from Forklift
5.1.4 Demounting Standard Tire from Three Piece Wheel
5.1.5 Demounting Optional Tire from Single Piece Wheel
5.1.6 Wheel Cleaning
5.1.7 Wheel and Tire Inspection and Replacement
5.1.8 Tire and Wheel Lubrication
5.1.9 Mixing Hydrofill Solution
5.1.10 Filling Tire or a Tube within Tire with Hydrofill (a Calcium Chloride Solution)
5.1.11 Mounting Standard Tire on Three Piece Wheel
5.1.12 Mounting Optional Tire on Single Piece Wheel
5.1.13 Connecting Core Ejector Tool to Tire Valve Stem
5.1.14 Filling a Tire with Hydrofill (a Calcium Chloride Solution)
5.1.15 Installing a Wheel on the Forklift
5.1.16 Care of Core Ejector
5.1.17 Care of Pump
5.1.18 Tire Speed and Road Surface Limitations
5.1.19 Care and Storage of Tires

5.1.1 Removing Hydrofill from Tire or Tube within Tire

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. If tire or tube within tire is on the forklift, use a jack to raise the forklift until the tire is slightly deflected and the valve is at the bottom in the valve drain position, Fig. 5.1. Use jack stands to support the forklift in the raised position.
3. Connect core ejector tool (1, Fig. 5.4) to valve stem as described in paragraph 5.1.10.
4. With the pump control in the CHECK position, unscrew and retract core housing into ejector body.
5. Start pump and turn pump control to EVACUATE position and run until tire is completely evacuated.
6. Check to determine if the valve stem is plugged by removing the core ejector tool. Run a piece of wire through the stem to make sure it is not plugged.
7. Turn pump control to CHECK position, stop pump, replace core housing in valve stem, stop pump and disconnect core ejector.
8. If there is no tube within the tire, unseat beads and demount front bead from rim and pump remaining hydrofill solution from tire.

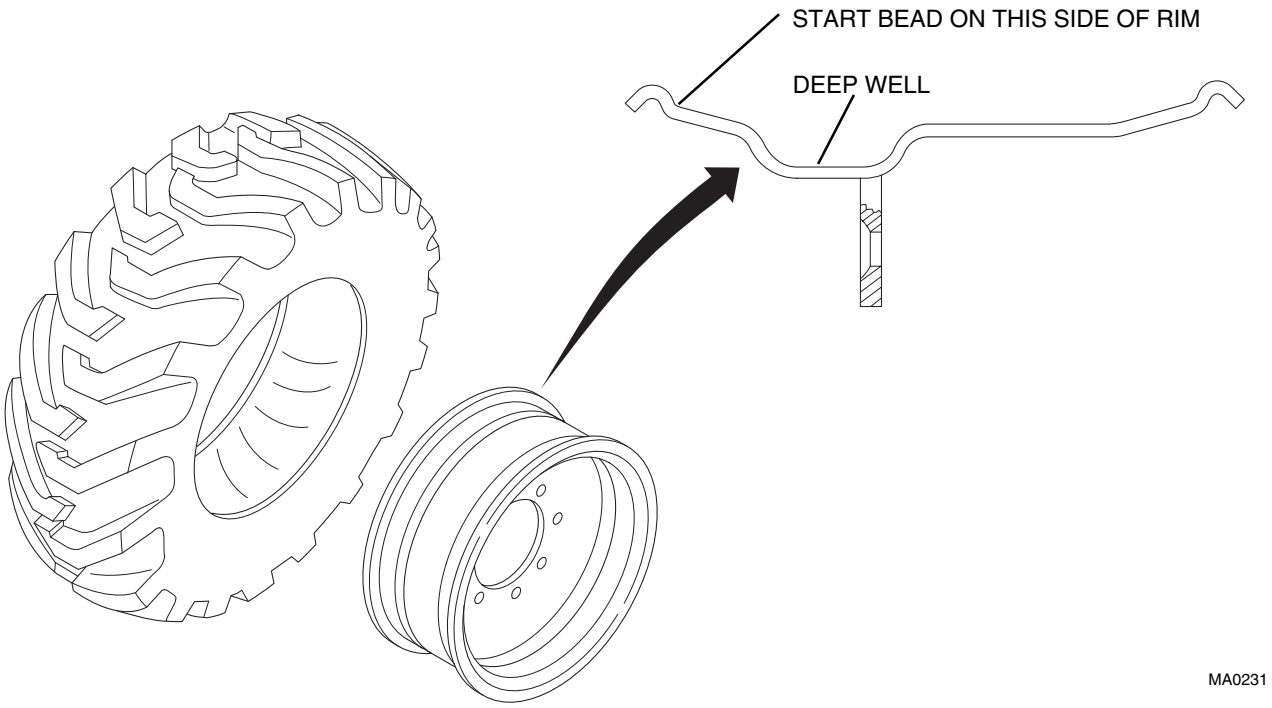


Fig. 5.3 Optional Wheel Assembly with Single Piece Rim

5.1.2 Demounting Tire

IMPORTANT: *Always completely deflate tire as described in paragraph 5.1.1 before you attempt to demount tire.*

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. To remove a wheel from the forklift refer to paragraph 5.1.5.

5.1.3 Removing Wheel from Forklift

The tires are filled with air and hydrofill which is a calcium chloride and water solution. Usually this solution is removed from the tire (as described in paragraph 5.1.1) before the wheel is removed from the forklift.

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Use a jack to raise the forklift. Rotate wheel to position tire valve at bottom and then lower wheel until tire is slightly deflected.
3. Remove hydrofill from tire or tube as described in paragraph 5.1.1.

IMPORTANT: *Always completely deflate tire as described in paragraph 5.1.1 before you attempt to demount tire.*

4. Loosen the wheel lug nuts.
5. Use a suitable hoist or jack to raise the axle until the tire clears the ground. Use approved jack stands to support the forklift ; never rely solely on jack or hoist.
6. Remove the wheel lug nuts, Fig. 5.1, and wheel and tire assembly from the axle hub.

5.1.4 Demounting Standard Tire from Three Piece Wheel

IMPORTANT: *Always completely deflate tire as described in paragraph 5.1.1 before you attempt to demount a tire.*

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Place the wheel and tire assembly on the floor on blocks with the loose side flange side up, Fig. 5.2.
3. After deflating the tire as described in paragraph 5.1.1, drive the hooked ends of two bead unseating tools between the tire bead and rim flange about 5 inches apart; be careful that you don't damage the tire bead area. Pry both tools down and out. Leave one tool in position and place the second about 5 inches beyond. Repeat the operation slowly, in successive steps, until tire bead is completely unseated.

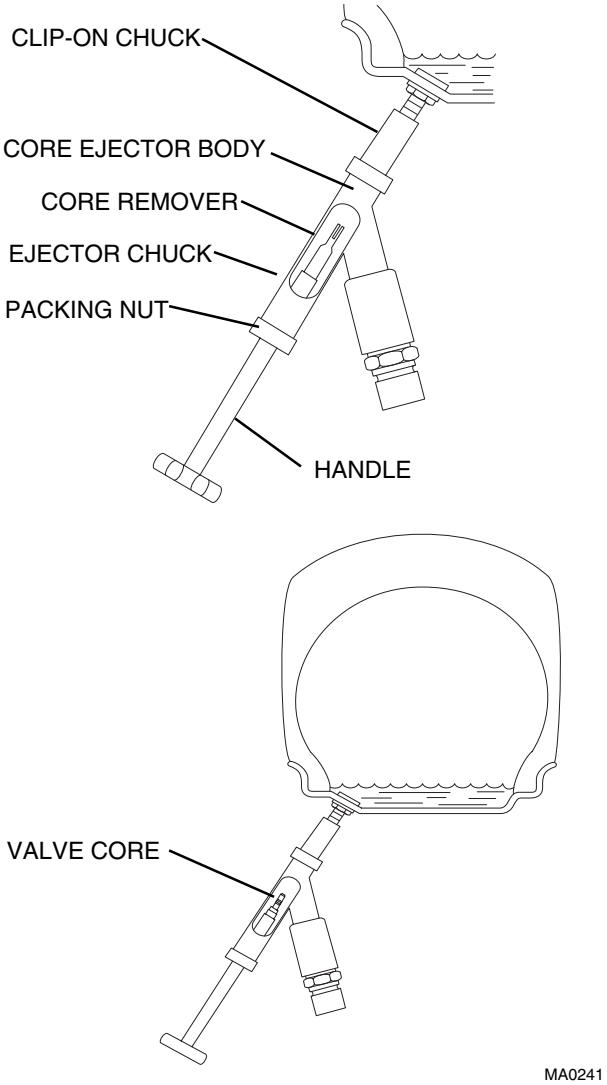


Figure 5.4 Core Ejector Tool

NOTE: A mechanical bead unseating and seating tool may be purchased from the Iowa Mold Tooling Company to facilitate step 3.

4. After the tire bead is unseated, stand on the flange and tire side wall to depress the flange down along the rim base; then, pry loose the lock ring. Keep fingers out of the way.
5. Hold the side flange down with the hooked end of a bead unseating tool and remove the O-ring from the O-ring groove.
6. Remove the side flange. Turn tire and rim over and unseat second bead by inserting both bead unseating tools between the bead and rim flange as in step 3. Repeat step 3 until the tire bead is completely broken loose from the rim on the fixed flange side. Lift rim base out of tire.
7. Refer to paragraph 5.1.11 for tire mounting instructions

5.1.5 Demounting Optional Tire from Single Piece Wheel

IMPORTANT: *Always completely deflate tire as described in paragraph 5.1.1, before you attempt to demount a tire.*

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Place the wheel and tire assembly on the floor on blocks with the narrow ledge on the bottom, Fig. 5.3.

NOTE: A mechanical bead unseating and seating tool may be purchased from the Iowa Mold Tooling Company to facilitate step 3.

3. After deflating tire as described in paragraph 5.1.1, drive the hooked ends of two bead unseating tools between tire bead and rim flange about 5" (130 mm) apart; be careful that you don't damage the tire bead area. Pry both tools down and out. Leave one tool in position and place the second about 5" (130 mm) beyond. Repeat the operation slowly, in successive steps, until tire bead is completely unseated.
4. Turn the tire and wheel over and unseat the second bead as described in step 3.
5. Thoroughly lubricate rim flange and tire bead with a thin solution of vegetable oil soap in water or equivalent rubber lubricant recommended for this requirement (never use petroleum-base lubricants or silicones).
6. Force part of bead across rim from valve into well. Starting at valve, pry bead over rim flange using two 18" (500 mm) tire irons. Continue by taking short bites to avoid damage to bead until top bead is completely over the rim flange.
7. Bring assembly to upright position and pull tube out of tire casing. When only tube requires repair or replacement, thoroughly inspect inside of tire casing for foreign material or damage and make sure both tube and inside of casing are dry before reinserting tube.
8. To completely remove tire from rim, turn assembly over and lubricate second tire bead and rim flange. Be sure one side of bead still on the rim is in the rim well and insert tire irons under opposite side of bead. Work rim slowly out of tire by taking small bites alternatively using both tire irons.

9. Remove the valve stem from the rim base.
10. Refer to paragraph 5.1.12 for tire mounting instructions.

5.1.6 Wheel Cleaning

Remove all rust, corrosion, dirt, and other foreign material from all metal surfaces. This is especially important in the rim gutter and bead areas, and mating surface of the lock ring.

Warning !

Assembling dirty or rusty rim components is dangerous. Dirt and rust prevent components from seating properly which could result in an explosive separation. Such explosions could result in severe injury or death to the operator and to those in the area.

5.1.7 Wheel and Tire Inspection and Replacement

1. Inspect the air-liquid valve core and stem, Fig. 5.2. Replace the entire valve if either component is damaged. Replace the core O-ring and stem seal regardless of condition.
2. Replace any tire that is worn or cut through the cords. When replacing tires, follow the tire manufacturers recommendations.
3. Check all metal surfaces for rust, corrosion, cracks, bent flanges, sprung lock ring, and deep tool marks on rings or gutter areas. Replace all damaged, worn out, or cracked parts.
4. Replace the rim base and/or lock ring if there is any wearing away of the metal mating surfaces and/or if they are deformed, broken or cracked, or pitted from corrosion.
5. Replace the sealing ring regardless of condition.

5.1.8 Tire and Wheel Lubrication

1. Apply lubricant to the bead seat area, tire bead, and rim mating surfaces prior to mounting the tire.
2. Use only those lubricants recommended by rim and tire manufacturers.
3. Lubricate the new sealing ring with an approved vegetable-based lubricant.

5.1.9 Mixing Hydrofill Solution

Prepare the hydrofill mixture by pouring calcium chloride into water; never add water to calcium chloride as considerable heat is generated in this mixing process. Let the solution cool to atmospheric temperature before pumping it into the tire. To mix and cool the solution, place the pump control in the FILL position and use the pump to circulate the solution through the core ejector body and back into the reservoir.

5.1.10 Filling a Tire or a Tube within a Tire with Hydrofill

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Place the wheel assembly with the valve stem straight up in a safety cage, Fig. 5.1. Attach clip on chuck, insert the valve core in the stem, Fig. 5.2, then withdraw handle of core ejector tool. Stand to the side during inflation.
3. Pressurize the tire to approximately 3 psi (0,21 bar). Check for proper alignment of all components.
   - If assembly is incorrect, STOP, DEFLATE, correct the assembly and repeat the procedure.
   - If assembly is okay, continue to inflate to 35 psi (2,4 bar).

Warning !

Never inflate beyond 35 psi (2,4 bar) pressure. If beads have not seated by the time pressure reaches 35 psi (2,4 bar), deflate the assembly, reposition the tire on the rim, relubricate and reinflate. After seating beads, adjust inflation to recommended pressure. Allowing air pressure to build within the assembly in an attempt to seat the beads is a DANGEROUS PRACTICE. In seating beads, inflation beyond 35 psi (2,4 bar) may break the bead (or even the rim) with explosive force sufficient to cause serious physical injury or death.

4. To fill a tire 75 percent with water solution, first inflate tire to 35 psi (2,4 bar) after the beads have been fully seated in the mounting procedure. Jack up the wheel, if done on a forklift, and turn the wheel to bring valve to top position.

5. Inspect both sides of the tire to be sure beads are evenly seated. If not, completely deflate tire, unseat beads and repeat entire mounting procedure.
6. Lower jack until tire is slightly deflected. With pump not running and the pump control handle at CHECK position, connect ejector and remove core housing as described in paragraph 5.1.1.
7. After connection is made, bleed pressure down to about 5 psi (0,35 bar) by moving pump control to EVACUATE. This is sufficient pressure to keep the beads seated on the rim.
8. When this point is reached, start pump and move pump control to the FILL position and start hydroinflating the tire.
9. Check pressure in tire periodically with pump gauge by placing pump in NEUTRAL or CHECK position.
10. If pressure exceeds 20 psi (1,4 bar), move pump control to EVACUATE until pressure is bled back to not less than 5 psi (0,35 bar).
11. After pressure is lowered, continue pumping. Repeat above steps as often as may be necessary until water or solution weight added to the assembly is equal to that shown in the table.
12. Replace core housing in valve stem by pushing handle (4) in until contact is made; turn handle clockwise until core housing is screwed tight in valve stem.
13. Withdraw handle, set pump to EVACUATE, and pump all liquid from hose.
14. Shut off pump.
15. Unscrew ejector body (2) from valve.
16. To assure fully-seated beads inflate tire to 35 psi (2,4 bar) using a standard air line, and then with valve stem at top, bleed pressure–and excess water or solution–down to 1 to 2 psi (0,07 to 0,14 bar) above recommended inflation.
17. Set final working pressure after tire has been mounted on forklift and with weight of forklift on tire. Position the wheel so valve stem is at the bottom position. Use an air-water gauge to check inflation pressure of each tire at least once a week.
18. Insert the valve core in the stem and pressurize the tire as follows:

    AIR PRESSURES:

    13.00 x 24 Size, 10 ply (Standard)
    55 psi (3,79 bar)

    15.00 x 19.5 Size, 12 ply (Optional)
    60 psi (4,14 bar)

    HYDROFILL MIXTURE:

    13.00 x 24, 10 ply (Standard)
    164 lb (74 kg) Calcium Chloride
    to 33 gal. (125 liter) of water (each tire)

    15.00 x 19.5, 12 ply (Optional)
    120 lb (54 kg) Calcium Chloride
    to 24 gal. (91 liter) of water (each tire)

5.1.11 Mounting Tire

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Refer to paragraph 5.1.12 or 5.1.13 when mounting tire on wheel which is not attached to forklift.

5.1.12 Mounting Standard Tire on Three Piece Wheel

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Install the valve stem, Fig. 5.2, into the hole in the rim and tighten to 45 to 55 lb-inch (5 to 6,2 N m). Make sure parts are clean, repainted if necessary, and have been inspected for damage and cracks before proceeding with mounting.
3. Make sure correct parts are being assembled. Lay rim base on block with the flange side down. Place tire over rim base.

NOTE: A mechanical bead unseating and seating tool may be purchased from the Iowa Mold Tooling Company to facilitate step 4.

4. Place side flange over rim base and push straight down with hands as far as possible. Make sure flange does not bind on rim base.
5. Stand on side flange to position it below both grooves in rim base and snap lock ring into lock ring (Upper) groove. Be certain the embossed "safety bulge" on the lock ring is up toward the operator.

6. Lubricate a new rubber O-ring. Place O-ring in groove on one side and stretch O-ring snapping it into place rather than rolling it into place. The lubricate the entire O-ring groove areas with an approved vegetable-based lubricant.

NOTE: It may be necessary to hold the side flange down with the flat end of the tire iron to expose the O-ring groove.

7. Check the components to make certain they are correctly assembled . The lock ring must be fully seated in its gutter.
8. Partially inflate tube and insert in tire casing with valve located near valve hole in rim. Attach valve retrieval tool to valve and thread tool through valve hole (inserting the tube and attaching the tool may be facilitated by placing a block under the tire).
9. Inflate tire using hydrofill as described in paragraph 5.1.10.

5.1.13 Mounting Optional Tire on Single Piece Wheel

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Install the valve stem, Fig. 5.3, into the hole in the rim and tighten to 45 to 55 lb-inch (5 to 6,2 N m). Make sure parts are clean, repainted if necessary, and have been inspected for damage and cracks before proceeding with mounting.
3. Place rim on floor with narrow ledge on top.
4. Lubricate bottom tire bead and top rim flange with a thin solution of vegetable oil soap in water or equivalent rubber lubricant recommended for this requirement (never use petroleum-base or silicone lubricants).

NOTE: A mechanical bead unseating and seating tool may be purchased from the Iowa Mold Tooling Company to facilitate step 5.

5. Push bottom bead over rim as far as possible. Use 36" tire irons to work the first bead completely over rim flange, taking **small** bites and being careful not to damage bead.

NOTE: On deep well rims, start bead on rim nearest deep well, Fig. 5.3.

6. Partially inflate tube with air and insert in tire casing with valve located near valve hole in rim. Attach valve retrieval tool to valve and thread tool through valve hole (inserting the tube and attaching the tool may be facilitated by placing a block under the tire).
7. Starting opposite the valve, use tire irons to lever top bead over the rim flange and down into rim well. Be careful to avoid pinching tube with tire irons. Locking pliers may be used to "keep your place". When bead is well started lubricate remaining unmounted portion of tire bead and rim flange. Taking small bites, spoon tire bead over rim flange until final section drops over at valve.
8. Thoroughly lubricate tire beads and rim bead seats on both sides of tire.
9. Center tire on rim and inflate to fully seat bead [do not exceed 35 psi (2,4 bar)] using an extension hose with clip-on chuck and gauge to permit operator to stand clear of tire. Then remove valve core and completely deflate. Reinsert valve core and reinflate to recommended pressure as described in paragraph 5.1.10.

NOTE: If either bead should fail to seat at 35 psi (2,4 bar) inflation, the tire may be pinched between tire bead and rim or something else is interfering with proper mounting. Do not increase pressure to seat beads, but remove valve core and completely deflate. Break both beads loose from rim, relubricate both tire beads and rim bead seat areas. Reinstall core and repeat inflation procedures.

5.1.14 Connecting Core Ejector Tool to Tire Valve Stem

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. With the pump not running and pump valve in CHECK position, screw core ejector body onto stem with handle (4) of core ejector pulled out.
3. Push handle of core ejector in until it makes contact with the core housing of the valve.
4. Hold the core ejector in you left hand and strike the handle (4) with your right hand to force the core housing in ejector chuck (6).
5. Turn handle (4) counterclockwise to unscrew the core housing, pushing inward lightly so you can feel the threads disengage when completely unscrewed.
6. Pull handle (4) out as far as it will go to retract core housing into ejector body. The handle will pull out easier if rotated while pulling, as packing nut (7) should be tight enough to prevent air or liquid leaks.

5.1.15 Installing a Wheel on the Forklift

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Remove the wheel assembly from the safety cage and place it on the axle hub.
3. Secure the wheel assembly to the axle hub with ten wheel lug nuts. Torque the nuts to 450 to 500 lb-ft (612 to 680 N m). Use the torquing sequence shown in Fig. 5.5.

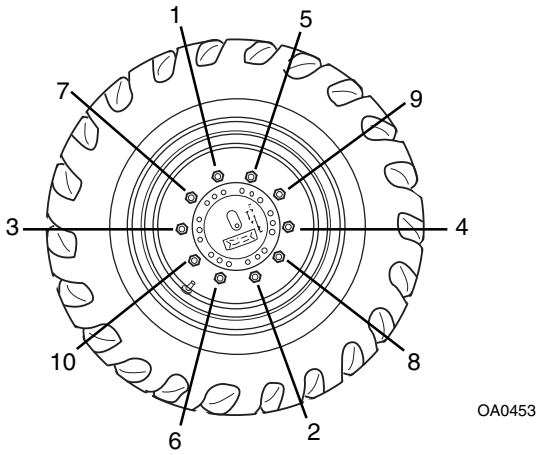


Fig. 5.5 Wheel Torque Sequence

4. Remove the jack stands and lower the tire to the ground.

5.1.16 Care of Core Ejector

Keep packing nut (7) on plunger fairly tight to avoid leaks. However, do not set it so tight that plunger cannot easily be pushed into position. When not in use for long periods of time, keep core ejector submerged in a container of clear water.

5.1.17 Care of Pump

Do not pump all of the solution out of the reservoir. A small amount of solution is required to keep air out of the pump and thus prevent corrosion and sticking. If water is used, be sure to place pump and reservoir where the water will not freeze.

5.1.18 Tire Speed and Road Surface Limitations

Forklift tires are designed for low speed operations not exceeding 25 mph (40 km/hr). If the forklift is towed at high speeds on the highway, high temperatures may develop under the tread bars and weaken the rubber material and cord fabric. There may be no visible evidence of damage at the time. Later a premature failure occurs which experience shows was started by the overheated condition that developed when the unit was towed at high speed.

If tires are to operate for any length of time on roads or other hard surfaces, it is advisable to increase pressure in the tire to the maximum recommendation to reduce the movement of the tread bars that causes excessive wiping action.

5.1.19 Care and Storage of Tires

Store unmounted tires vertically on tread. If stored for an extended period, rotate tires periodically to reduce stress concentrations in the area of ground contact. Tires should not be stored flat and "stove piped" as they will become squashed and distorted, making mounting on the rim difficult–particularly for tubeless tires.

Inflated tires should be stored under the conditions noted above, with inflation pressure reduced to 10 psi (0,7 bar).

Tires should not be stored out-of-doors. However, it there is no alternative, tires so stored must be protected from the elements. An unbroken opaque covering is required as protection from sun and rain.

Exposure to weather will cause crazing and cracking of the rubber surfaces as well as deterioration of the tire carcass–particularly where rain water is permitted to accumulate in the tires.

When extended storage is anticipated, the forklift should be blocked up so the tires are out of ground contact. Inflation pressure in the tires should then be reduced to 10 psi (0,7 bar). Other precautions as noted above should be observed.

If it is not possible to block up the forklift, inflation pressure in the tires should be increased 25 percent. The forklift should be moved from time to time to change the location of stress concentrations in the tire ground contact area.

Store tires indoors in a cool, dark, dry area free from drafts. Both heat and light are sources of oxidation on the tire surfaces–a result of which is crazing and weather checking. Never store tires on oily floors or otherwise in contact with solvents, oil or grease. Further, tires should not be stored in the same area with volatile solvents. Such solvents are readily absorbed by rubber and will damage and weaken it.

Store tires away from electric motors, generators, arc welders, etc., since these are active sources of ozone. Ozone attacks rubber and causes crazing and weather checking.

5.2 AXLE ASSEMBLY

The axle assembly rotates and turns the wheels. Both front and rear axles consist of a differential carrier assembly, a left and right axle steering joint, and a left and right wheel end, Fig. 5.6. The front axle wheel ends contain service brakes. If the forklift has a turbocharged engine both the front and rear axle wheel ends contain service brakes.

⚠ Warning !

Do not attempt carrier and differential removal and installation and differential and pinion disassembly and assembly without thoroughly understanding instructions in Spicer® Dana publications and correspondence which applies to your forklift. Refer to paragraph 5.3.

- Wear safety glasses at all times when working on forklift and forklift components.
- If it becomes necessary to disassemble any parts inside the carrier, it is suggested that the entire axle be removed from the forklift and held tight in a stand or rack with carrier pinion positioned up.
- When removing axle assembly, make sure forklift is properly supported; an improperly supported vehicle can cause serious injury or death.
- If axle assembly is still in the forklift, be sure carrier, differential and pinion assemblies are securely supported before they are separated from the axle housing.
- A serious or fatal injury can occur if you lack proper training, if you fail to follow recommended procedures, if you do not use proper tools and safety equipment, if you assemble components improperly, if you use incompatible components, if you use worn-out or damaged components, or if you use components in a nonapproved application.
- Some manufacturers may require the assembly of brake components on Dana axles that use materials containing asbestos fibers. Breathing asbestos dust may be hazardous to your health and may cause serious respiratory or other bodily harm. Follow O.S.H.A. standards for proper protective devices when you work with asbestos materials.
- Before you use silicone rubber sealant (RTV) and lubricating grease and oils, become familiar with and follow all safety recommendations provided product manufacturer and supplier. When working with these products follow industrial hygiene practices (before eating, thoroughly wash hands and face). Do not eat, drink or smoke in areas where there is potential for significant exposure to these materials.
- When discarding materials observe all local, state, and federal laws and regulations for approved disposal procedures.

⚠ Caution !

The use of non-original equipment replacement parts is not recommended as their use may cause unit failure and affect vehicle safety. An identification tag on the axle housing contains the axle assembly number, the serial number and the build date. Supply all of the information on this tag when referring to components of the axle assembly. Refer to Spicer® Dana Maintenance Manual for Models PS/PR-7036 for gear set identification instructions.

- Be extremely careful when working on components using snap rings or spring-loaded retention devices.
- Wear industrial strength safety goggles or glasses whenever you work on the forklift or forklift components.
- It is impossible to know, evaluate and advise the service trade of all conceivable ways in which service might be done or of the possible hazardous consequences of each way. Accordingly, whenever you use a service procedure or tool which is not recommended you must first satisfy yourself thoroughly that neither personal or vehicle safety will be jeopardized by the service method you select.

IMPORTANT:

- *When replacing a fastener, replace it with one of equal or higher grade and quality. Torque fasteners are recommended for the application.*
- *Some service operations require the use of tools specifically designed for the purpose. Use the special tools when and as recommended.*
- *Hammering on end yokes or flanges to remove or install them is not only destructive to the yoke or flange itself, but can also cause serious internal damage. Hammering on end yokes can close the bearing bores or misalign yoke lugs and result in early failures of journal needle bearings or other driveline components. Serious damage can also be done internally to the ring and pinion set or pinion bearings by hammering on external parts. Remove and install end yokes by following recommended procedures.*
- *Do not reuse oil or grease seals.*

CLEANING: Clean parts with machined or ground surfaces such as gears, bearings, and shafts with emulsion cleaners or petroleum based cleaners. Steam cleaning of internal components and the interior of the planetary hub and axle housing is not recommended. Water can cause corrosion of critical parts. Rust contamination in the lubricant can cause gear and bearing failure. Clean all surfaces of old gasket material.

DRYING: Use clean lint-free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication. After drying, lightly coat components with oil or rust preventive to protect them from corrosion. If components are to be stored for a prolonged period they should be wrapped in wax paper.

PERIODIC OPERATION REQUIREMENT: EVERY TWO WEEKS drive the forklift far enough to cause the drivetrain components to make several complete revolutions. This procedure will help assure that all internal components receive adequate lubrication to minimize component deterioration caused by an undesirable environment such as high humidity.

SUBMERSION OR DEEP WATER FORDING: If the vehicle is exposed to water deep enough to cover the hubs, disassemble the wheel ends and inspect for water damage and contamination. If you submerge the carrier housing in water, particularly over the breather, drain the hypoid gear lubricant and inspect internal parts for water damage and contamination. Before you assemble and refill the unit with the specified lubricants, clean, examine, and replace damaged parts. Clean, examine, and replace damaged parts if necessary.

NOTE: If the hubs are exposed to deep water, it is possible that water could enter the carrier at the point the inner axle shaft enters the axle housing. This could also necessitate the draining of the hypoid lubricant as described above. Whenever you remove bearings, replace them with new bearings, regardless of mileage. Use suitable pullers for bearing removal. Clean, inspect, and lubricate all bearings just prior to reassembly. If replacement of a damaged bearing cup or cone is necessary, replace the cup and cone as a set.

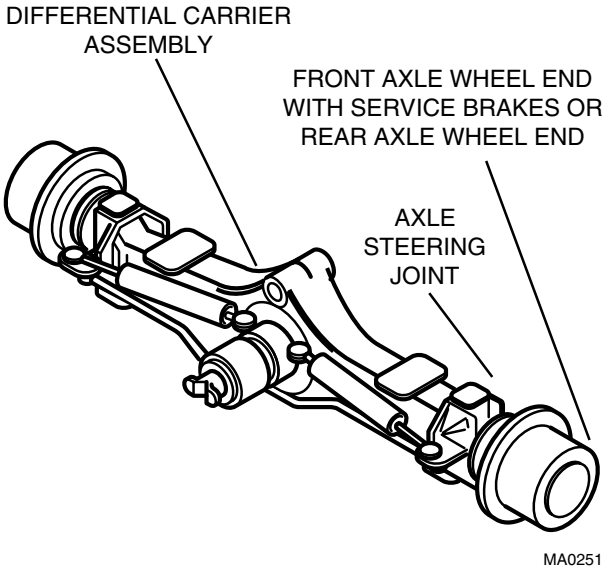

DIFFERENTIAL CARRIER ASSEMBLY
FRONT AXLE WHEEL END WITH SERVICE BRAKES OR REAR AXLE WHEEL END
AXLE STEERING JOINT
MA0251

Fig. 5.6 Axle

5.2.1 Axle

a. Removal

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Place adequate support under the frame so that it will remain in place when the axle assembly is removed.
4. Remove the wheels from the axle as described in paragraph 5.1.3.
5. Use floor jacks or install a suitable hoist at the ends of the axle. Take up the slack.
6. Disconnect hydraulic hoses as required from steering cylinders, service brakes and park lock.
7. Remove the drive shaft from the axle input shaft end yoke, Fig. 5.7.
8. Remove the capscrew and locknut securing the axle pivot pin to the frame. Remove the pivot pin and shims.

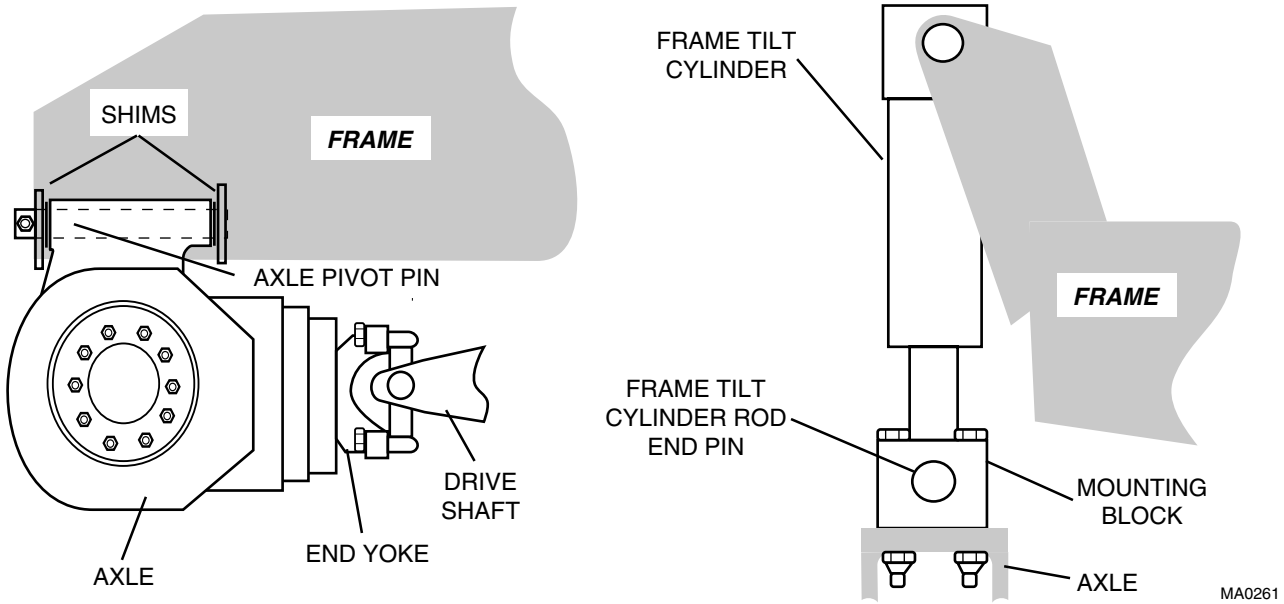
NOTE: To remove the pivot pin from the front axle:

- *thread a 1/2" bolt into front end of pin and pull or pry on bolt or drain fuel from fuel tank.*

or

- *remove tank and drive pin out from the back side.*

Fig. 5.7 Axle Connections

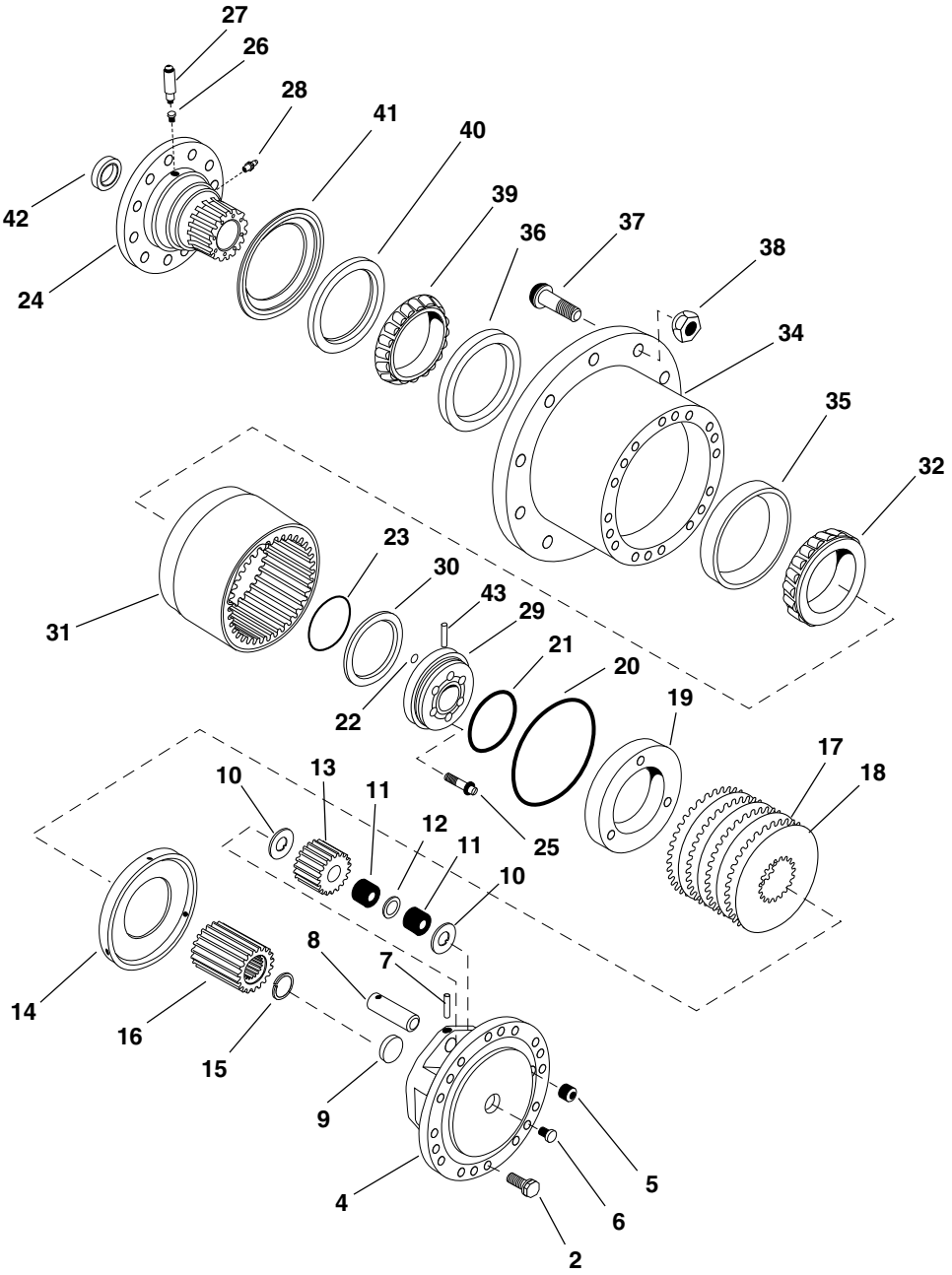


9. At the front axle, remove two retaining rings from the frame tilt cylinder rod end pin, Fig. 5.7. Tap the pin from the mounting blocks.
10. Using the hoist, remove the axle from the frame and place it on a support at three points of the housing. A suitable holding stand is desirable, but not necessary. Refer to Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for internal servicing instructions.

b. Installation

1. Using a suitable hoist, remove the axle from its support or stand and position it under the frame so that pivot pin holes are aligned with hole in axle.
2. Install the axle pivot pin and shims. There must be no more than a 0.10" (2,5 mm) gap between the frame and axle. Secure the pin in place with a capscrew and locknut. Tighten locknut until snug against collar, then an additional 1/4 turn.
3. Secure the frame tilt cylinder rod end to the frame mounting blocks, Fig. 5.7, with a pin and two retaining rings. The pin must pass easily through both mounting blocks. If not, shim the blocks as required. Lubricate the pin using the grease fitting on the cylinder rod.
4. Install the drive shaft on the axle input shaft end yoke. Be sure retaining rings are securely seated.

1. Drive Flange (items 2 thru 16)
   Wheel End (items 17 thru 43)



2. Screw, self-locking
3. Planetary Gear Assembly
4. Flange, planetary drive
5. Plug, drain/fill
6. Plug
7. Pin, roll
8. Shaft, planet gear
9. Washer, drive flange
10. Washer, keyed
11. Bearing, single roller
12. Ring, spacer
13. Gear, planet
14. Plate, lining stop
15. Ring, retaining
16. Gear, sun spur
17. Plate, lining stop
18 Disc Assembly
19. Piston
20. O-ring, piston OD
21. O-ring, piston ID
22. O-ring, oil passage
23. O-ring, retainer
24. Spindle Assembly
25. Screw
26. Seat, bleeder
27. Bleeder
28. Fitting, brake
29. Retainer
30. Shim
31. Gear, planetary ring
32. Cone, bearing (outer)
33. Hub Assembly
34. Hub, planetary
35. Cup, bearing (outer)
36. Cup, bearing (inner)
37. Bolt, wheel
38. Nut, wheel
39. Cone, bearing (inner)
40. Seal, oil
41. Deflector, seal
42. Seal, oil
43. Tubing, brake

Fig. 5.8 Wheel End and Drive

Flange—Front Axle and Service Brakes

5. Connect hydraulic hoses as required to steering cylinders, service brakes and park lock. Bleed the lines to the service brakes and park lock.
6. Remove the hoist from the ends of the axle.
7. Install the wheels on the axle as described in paragraph 5.1.15.
8. Remove the support from under the frame.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

9. Start the engine. Turn the steering wheel several times to purge any air in the steering cylinder hydraulic lines.

5.2.2 Wheel End With Service Brakes

If removing the entire axle assembly from the forklift refer to paragraph 5.2.1. A suitable holding stand is desirable, but not necessary. If the axle is to remain on the forklift, use support stands under machine and axle.

Steam clean the axle assembly prior to disassembly. Seal all openings before steam cleaning.

Refer to wheel and tire removal instructions in paragraph 5.1.3 and 5.1.2.

Except when servicing the planetary gear assembly, raise axle until pressure is relieved from wheel end and lower axle onto support stands.

Warning !

Wear safety glasses at all times when assembling and disassembling the axle. The smallest eye injury may cause loss of vision.

Planetary Gear Assembly

a. Removal

Refer to page 13 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for removal instructions.

b. Disassembly

Refer to page 14 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for disassembly instructions.

c. Cleaning and Drying

1. Clean the groove under drive flange washer (9, Fig. 5.8). It is an access to the air vent.
2. Clean all parts with an approved petroleum based cleaner.
3. Use clean lint free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.
4. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

d. Inspection and Replacement

1. Replace drive flange washer (9, Fig. 5.8) if worn.
2. Replace planet gears (13) if worn, scored, or chipped.
3. Replace single roller bearings (11) if worn, pitted, or damaged.
4. Replace keyed washers (10) if worn, pitted, or scored.
5. Replace planet gear shaft (8) if worn or scored.

e. Assembly and Installation

1. Refer to page 31 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for assembly and installation instructions.
2. Install the planetary gear assembly as described in paragraph 5.2.2.
3. After the drive flange is installed, rotate the hub so drain/fill plug (5, Fig. 5.8) is up and fill hub with JLG Special Wet Disc Brake Fluid (8522042).

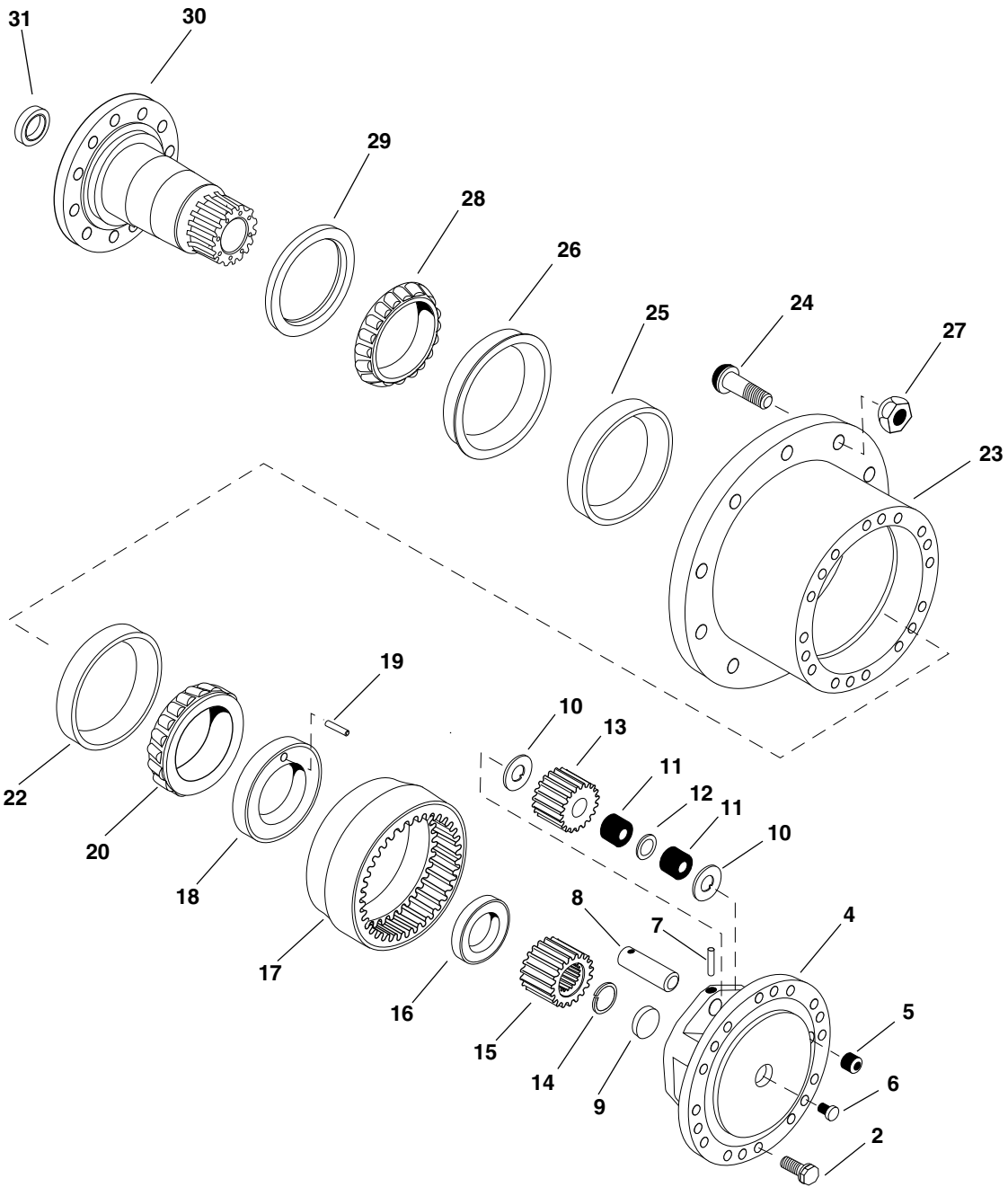
Wheel End Service Brakes

a. Disassembly

Refer to pages 15 and 16 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for disassembly instructions.

b. Cleaning and Drying

1. Clean all parts with an approved petroleum based cleaner.
2. Use clean lint free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.



1. Wheel End Assembly
2. Screw, self-locking
3. Planetary Gear Assembly
4. Flange, planetary drive
5. Plug, drain/fill
6. Plug
7. Pin, roll
8. Shaft, planet gear
9. Washer, drive flange
10. Washer, keyed
11. Bearing, single roller
12. Washer, planet gear
13. Gear, planet
14. Ring, retaining
15. Gear, sun spur
16. Spacer, flat
17. Gear, planetary ring
18. Locknut
19. Pin, roll
20. Cone, bearing (outer)
21. Hub Assembly
22. Cup, bearing (outer)
23. Hub , planetary
24. Bolt, wheel
25. Cup, bearing (inner)
26. Slinger, hub oil
27. Nut, wheel
28. Cone, bearing (inner)
29. Seal, oil
30. Spindle Assembly
31. Seal, oil

Fig. 5.9 Rear Axle Drive

Flange and Wheel End Without Service Brakes

3 After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

c. Inspection and Replacement

1 Replace all discs and plates as a set if any of the following conditions exist:
- friction material groove depth on any disc is less than 0.005" (0.127 mm),
- plates are warped as determined by a straight edge, or
- any plate or disc is heat damaged.

2. Replace all O-rings regardless of condition.

3. Replace all bearings, cups, and cones if they are worn, pitted, or damaged.

4. Replace all gears that are worn, pitted, scored, or chipped.

d. Assembly

Refer to page 28 through 30 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for assembly instructions.

5.2.3 Wheel End Without Service Brakes

If removing the entire axle assembly from the forklift refer to paragraph 5.2.1. A suitable holding stand is desirable, but not necessary. If the axle is to remain on the forklift, use support stands under machine and axle.

Steam clean the axle assembly prior to disassembly. Seal all openings before steam cleaning.

Refer to wheel and tire removal instructions in paragraph 5.2.1.

Except when servicing the planetary gear assembly, raise axle until pressure is relieved from wheel end and rest axle on support stands.

Warning !

Wear safety glasses at all times when assembling and disassembling the axle The smallest eye injury may cause loss of vision.

a. Disassembly

1. Remove the planetary gear assembly. Refer to page 13 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for removal instructions.

2. Support the hub assembly with a lifting device.

3. Refer to page 15 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for disassembly instructions.

b. Cleaning and Drying

1. Clean all parts with an approved petroleum based cleaner.

2. Use clean lint free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.

3. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

c. Inspection and Replacement

1. Replace all bearings, cups, and cones if they are worn, pitted, or damaged.

2. Replace all gears that are worn, pitted, scored, or chipped.

d. Assembly

1. Secure the spindle assembly to the steering knuckle with locknuts and washers.

2. Refer to page 31 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for assembly instructions.

5.2.4 Axle Steering Joints

If removing the entire axle assembly from the forklift refer to paragraph 5.2.1. A suitable holding stand is desirable, but not necessary. If the axle is to remain on the forklift, use support stands under machine and axle.

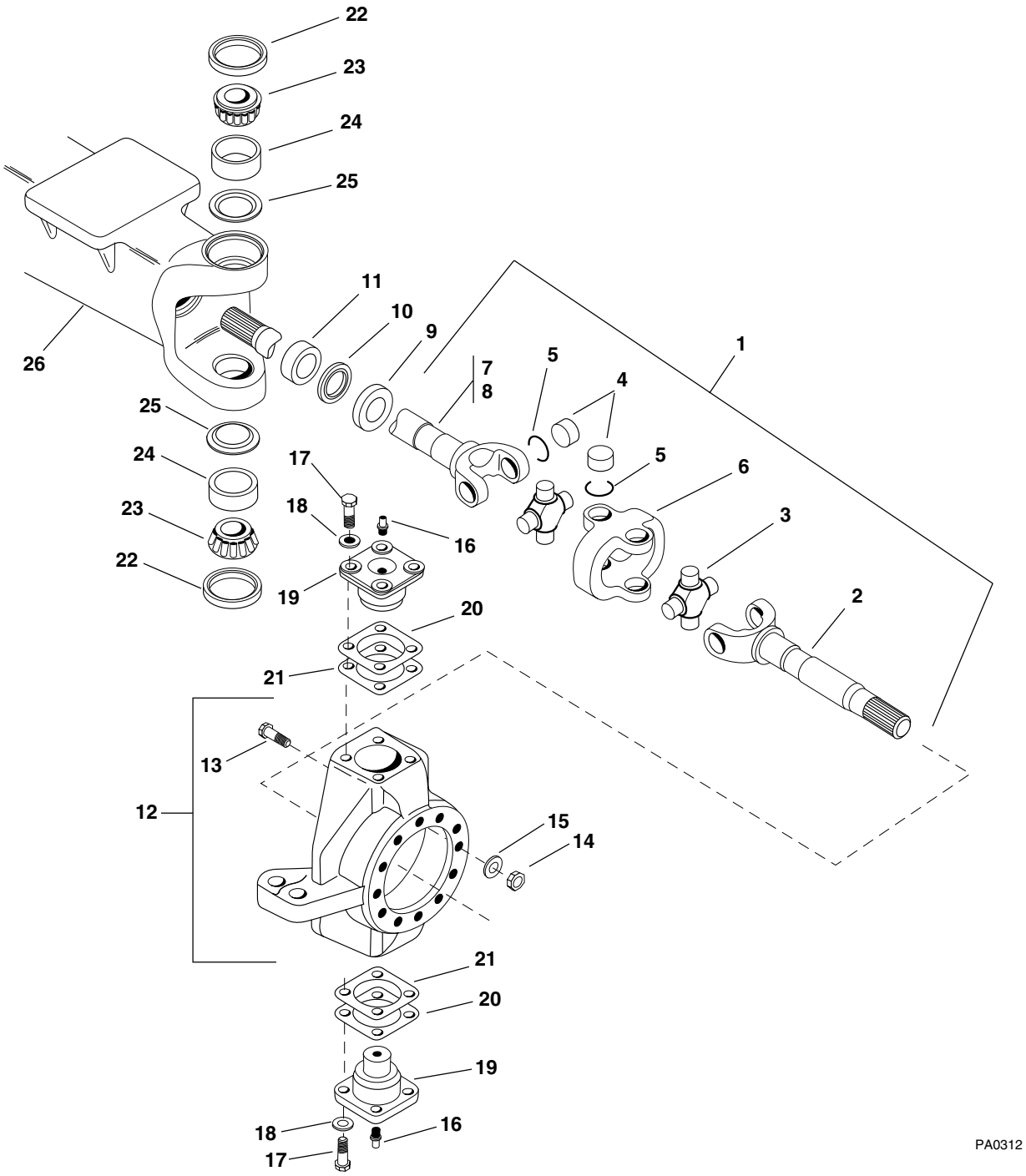
Steam clean the axle assembly prior to disassembly. Seal all openings before steam cleaning.

Refer to wheel and tire removal instructions in paragraph 5.2.1.

Except when servicing the planetary gear assembly, raise axle until pressure is relieved from wheel end and rest axle on support stands.

Warning !

Wear safety glasses at all times when assembling and disassembling the axle The smallest eye injury may cause loss of vision.



1. Shaft and Joint Assembly
2. Shaft, outer
3. Cross Assembly
4. Bearing Race Assembly
5. Ring, retaining
6. Yoke, center
7. Shaft, inner yoke, left
8. Shaft, inner yoke, right
9. Deflector, seal
10. Seal, oil
11. Bushing, spindle
12. Knuckle Assembly
13. Stud, dowel
14. Locknut
15. Washer, flat
16. Fitting, grease
17. Capscrew
18. Washer, flat
19. Cap, king pin
20. Shim, formed
21. Shim, formed
22. Seal, oil
23. Cone, roller bearing
24. Cup, roller bearing
25. Retainer, grease
26. Housing, axle

Fig. 5.10 Axle Steering Joints

a. Disassembly

1. Refer to page 13 through 16 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for removing and disassembling the drive flange and wheel end hub.
2. <u>On an axle with service brakes:</u>
   (a) Remove lining stop plates (14 and 17, Fig. 5.8) and disc assemblies (18).
   (b) Remove retainer screws (25) and planetary ring gear (31), piston (19), and retainer (29) as a unit.
   (c) Remove hub assembly (33).
3. <u>On an axle without service brakes:</u>
   (a) Support the hub assembly with a lifting device.
   (b) Insert a small screwdriver under retaining ring (14, Fig. 5.9) on the axle shaft and remove it by rotating around the shaft.
   (c) Remove the sun spur gear (15) and spacer (16) from the axle shaft.
   (d) Remove planetary ring gear (17). Use a suitable puller if necessary.

IMPORTANT: *Do not use a pilot puller on the axle shaft because it may damage the inboard axle seal.*

   (e) Remove roll pin (19, Fig 5.9) from locknut (18) or ring gear (17).
   (f) Remove the locknut using a three-pin spanner wrench.
   (g) Remove bearing cone (20).
   (h) Using a suitable lifting device, remove hub assembly (21) from spindle assembly (30)
4. Remove the spindle assembly mounting nuts and flat washers.
5. Tap the spindle with a soft-faced hammer to loosen the knuckle assembly (12, Fig. 5.10). Remove the spindle assembly.
6. Replace oil seal or bronze bushing (42, Fig. 5.8) or (31, Fig. 5.9) in the spindle bore.
7. Holding shaft and joint assembly (1, Fig. 5.10) level, pull the assembly straight out to avoid damaging inner shaft oil seal (10).
8. Remove oil seal (10) and spindle bushing (11) from the housing yoke bore.
9. Remove retaining rings (5).
10. Press out bearing race assemblies (4) and remove two crosses (3) and center yoke (6).
11. Refer to pages 20 through 22 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for disassembling the axle steering knuckle.

b. Cleaning and Drying

1. Clean all parts with an approved petroleum based cleaner.
2. Use clean lint free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.
3. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

c. Inspection and Replacement

1. Replace any bearing race assembly (4, Fig. 5.10) if it is worn, pitted, or damaged.
2. Replace cross assemblies (3) that are worn or damaged.
3. Replace axle shafts (2, 7, or 8) if there is evidence of torsional fractures or other indications of impending failure.

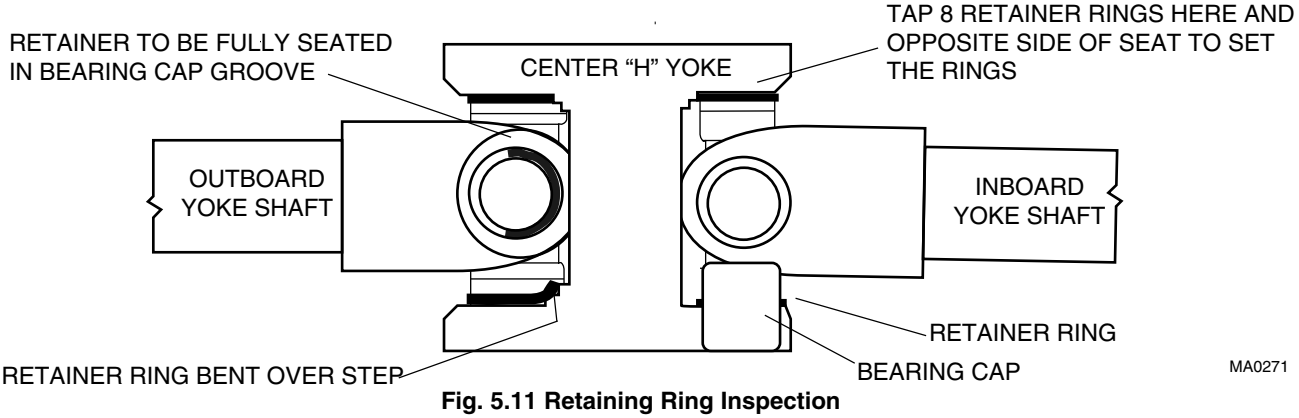

RETAINER TO BE FULLY SEATED IN BEARING CAP GROOVE
CENTER "H" YOKE
TAP 8 RETAINER RINGS HERE AND OPPOSITE SIDE OF SEAT TO SET THE RINGS
OUTBOARD YOKE SHAFT
INBOARD YOKE SHAFT
RETAINER RING
RETAINER RING BENT OVER STEP
BEARING CAP
MA0271

Fig. 5.11 Retaining Ring Inspection

4. Replace roller bearing cups (24) or cones (23) if any are worn, pitted, or damaged.
5. Replace oil seals (10 and 22) regardless of condition.

d. Retaining Ring Inspection

1. Place the forklift in "Crab Steer" mode and turn the steering wheel full left to access shaft assemblies on the right side of the vehicle
2. Using a flashlight, visually inspect the right front shaft assembly retaining rings through the opening between the axle housing and steering knuckle.
3. Turn the wheel end clockwise or counterclockwise to expose both sides of all eight retaining rings
4. Inspect for the following (Fig. 5.11):
   - full seating of the retaining rings into the cap grooves,
   - no back and forth movement of the ring,
   - and overlap on the machined steps on the inboard side of the yoke ear
5. To set the rings, tap suspected rings with a hammer and punch where shown on Fig. 5.11.
6. Inspect the right rear shaft assembly as instructed in steps 2 thru 5.
7. Turn the forklift steering wheel full right to access the shaft assemblies on the left side of the vehicle.
8. Inspect the left side shaft assemblies as instructed in steps 2 thru 5.

e. Assembly

1. Refer to page 23 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for steering knuckle assembly instructions.
2. Refer to page 25 through 31 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for axle shaft and spindle assembly and installation instructions.
3. Connect the tie rod and steering cylinder to the knuckle assembly. Torque the socket assembly nuts to 140 lb-ft (190 N m) minimum. Check to make sure the position of the offset in the tie rod clears the carrier assembly in full turn position (both directions). If full turn clearance is not found, switch the tie rod assembly around end for end and then retorque the slotted nuts.
4. Install cotter pins and bend each pin over to lock it in place.

NOTE: If the cotter pin cannot be installed after minimum torque is attained, the nut must be advanced until the cotter pin can be installed.

IMPORTANT: *If the tie rod adjustment (toe-in) has been changed it will be necessary to readjust it. Position the steering knuckles in a straight ahead (0° turn angle) position. Position measuring bars on the spindle mounting face of the steering knuckles. Measure across them on the carrier side and cover side of the axle housing and compare readings. If necessary, remove tie rod, adjust the overall socket to socket length (in or out), reinstall the tie rod assembly and remeasure. Repeat this procedure until equal measurements are attained for zero toe-in. A zero to 1/2° toe-in is acceptable. Retorque slotted nuts to 140 lb-ft (190 N m) minimum. Torque the tie rod clamp assembly bolts and nuts to 60 to 70 lb-ft (81 to 95 N m).*

5. If repairs were made to or the retracted length of the steering cylinder was inadvertently changed the retracted length of the assembly will require resetting as follows:
   (a) Remove slotted nuts from and remove rod end socket assemblies from steer knuckles. Push in or use air pressure to retract the rod into the barrel assembly of both cylinders.
   (b) Turn steering knuckle to full inside turn position on either right or left hand side.
   (c) Adjust the socket assembly position in or out on the rod end and also barrel end, if required, such that its retracted length matches the length required for assembly to its steer knuckle. Reconnect the cylinder assembly as described in step 3. Torque the cylinder socket clamp bolts and nuts to 60 to 70 lb-ft (81 to 95 N m).

IMPORTANT: *Protect the rod from damage while adjusting socket position.*

   (d) Turn the other steer knuckle to its full inside turn position. Adjust its steer cylinder retracted as noted in step c.
6. Connect the hydraulic hoses to the steering cylinders and "bleed" the system.
7. On an axle without service brakes:
   (a) Using lifting device, install hub assembly (21, Fig. 5.9) on spindle assembly (30).
   (b) Install bearing cone (20).
   (c) Install locknut (18); tighten to 200 to 250 ft. lbs. (272 to 340 N m). Back the nut off 1/8

turn and align any hole in the nut with a major spline on the spindle. Mark the end of the aligned spline on the edge of the spindle. Make sure the hub rotates freely.

(d) Install roll pin (19) on the back face of planetary ring gear (17) and mark its location on the front face of the gear.

(e) Install planetary ring gear, making sure roll pin is locked into locknut hole. Align mark on the edge of the spindle with the mark on the front face of the planetary ring gear.

(f) Install spacer (16), sun spur gear (15), and retaining ring (14) on the axle shaft.

8. On an axle with service brakes:

(a) Using a suitable lifting device, install the hub assembly onto the spindle.

(b) Install the planetary ring gear/piston/ retainer unit on the spindle assembly, being sure oil passage hole in ring gear is to the bottom of the axle at 6 o'clock.

(c) Gradually increase torque on retainer screws (25, Fig. 5.8) using a crossing pattern until 45 lb-ft (61 N m) is achieved on each screw.

(d) Install lining stop plates (14 and 17, Fig. 5.8 and Fig. 5.12) and discs (18).

9. Install the planetary gear assembly as described in paragraph 5.2.2.

5.2.5 Steering Cylinder and Tie Rod

a. Removal

Refer to page 20 through 22 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for removal instructions.

b. Cleaning and Drying

1. Clean all parts with approved petroleum based cleaner.
2. Use clean lint free towels to dry components after cleaning.
3. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

c. Inspection and Replacement

1. Be sure rod is straight and undamaged. If rod is bent or damaged, install new rod.
2. Check condition of tube, attaching hardware and hydraulic hoses. Repair or replace as required.

d. Installation

Refer to page 24 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for installation instructions.

5.2.6 Park Lock Unit

The park lock unit consists of the park lock and a yoke shaft.

a. Removal

Refer to page 54 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for removal instructions.

b. Disassembly

Refer to page 55 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for disassembly instructions.

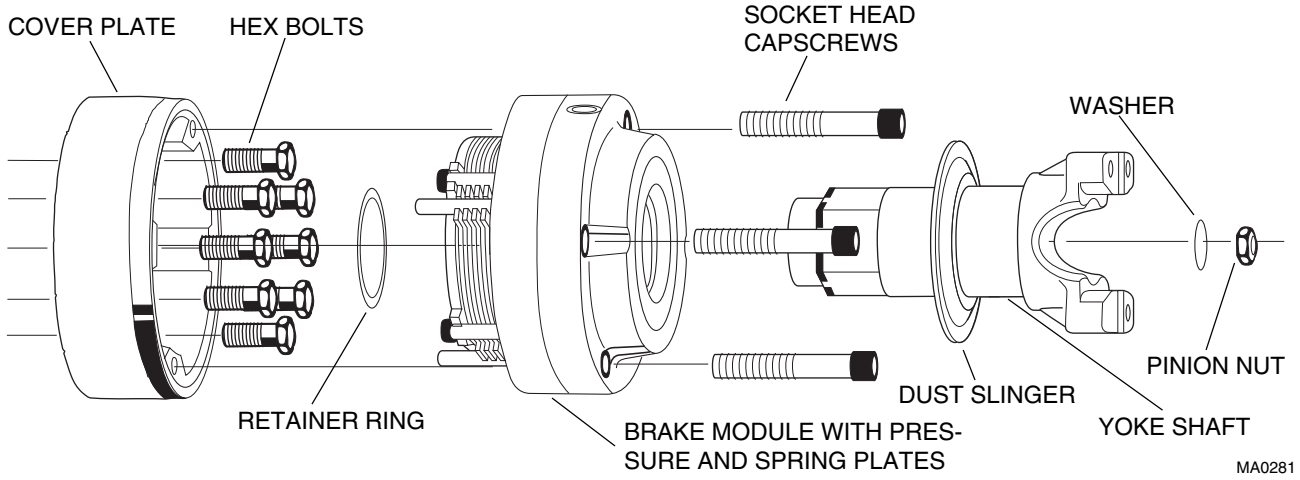
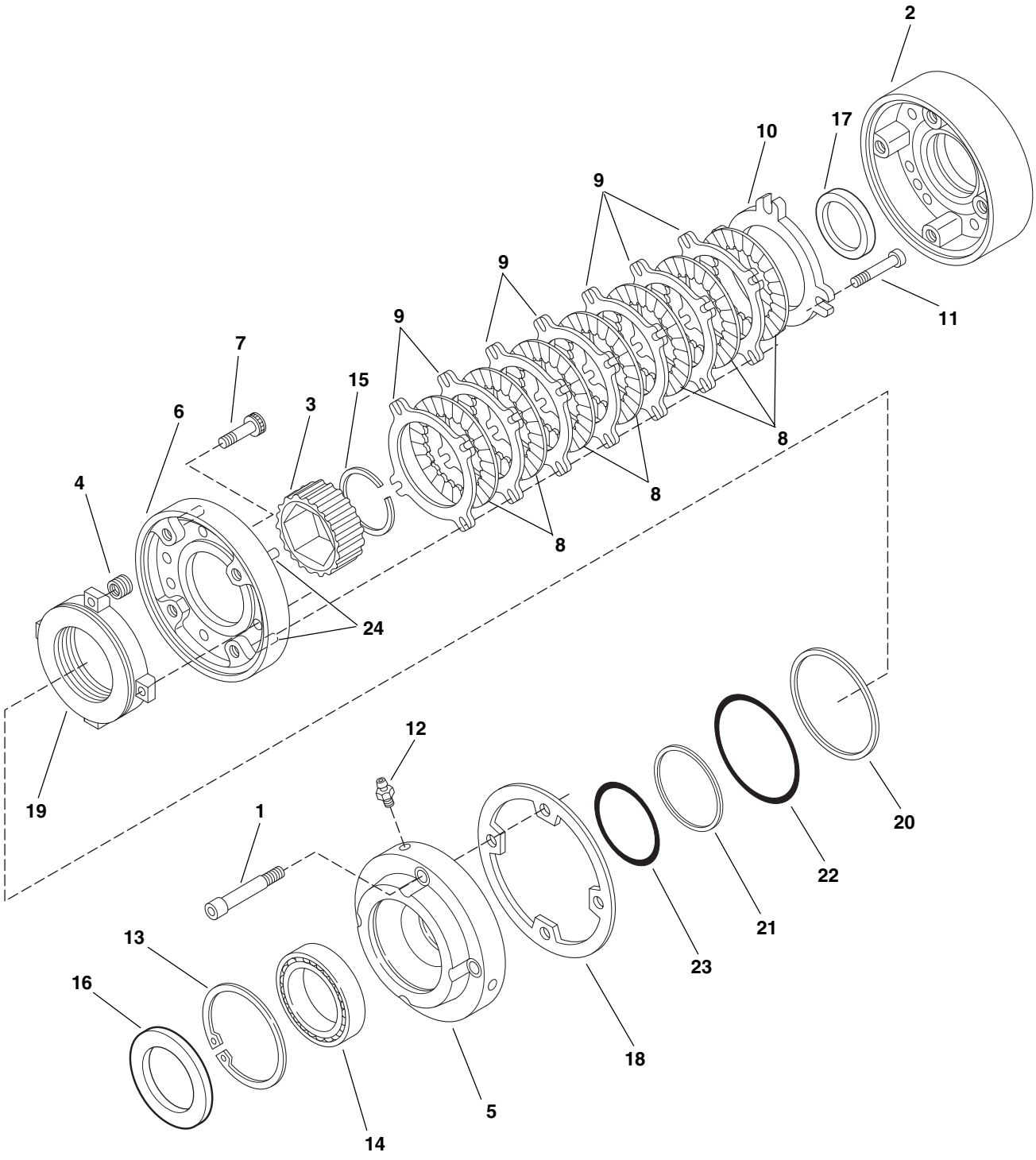


Fig. 5.12 Park Lock Removal



1. Screw, socket head cap (4)
2. Plate, cover
3. Spline, outer
4. Spring, red (12)
5. Plate, pressure
6. Plate, spring
7. Screw, socket head cap (4)
8. Disc, rotor (7)
9. Plate, lining (7)
10. Plate, thrust
11. Bolt, socket head shoulder (4)
12. Screw, bleeder
13. Ring, retainer
14. Bearing
15. Ring, retainer
16. Seal, oil
17. Seal, oil
18. Seal, case (2)
19. Piston
20. Ring, backup
21. Ring, backup
22. O-ring
23. O-ring
24. Pin, dowel (4)

Fig. 5.13 Exploded View of Park Lock

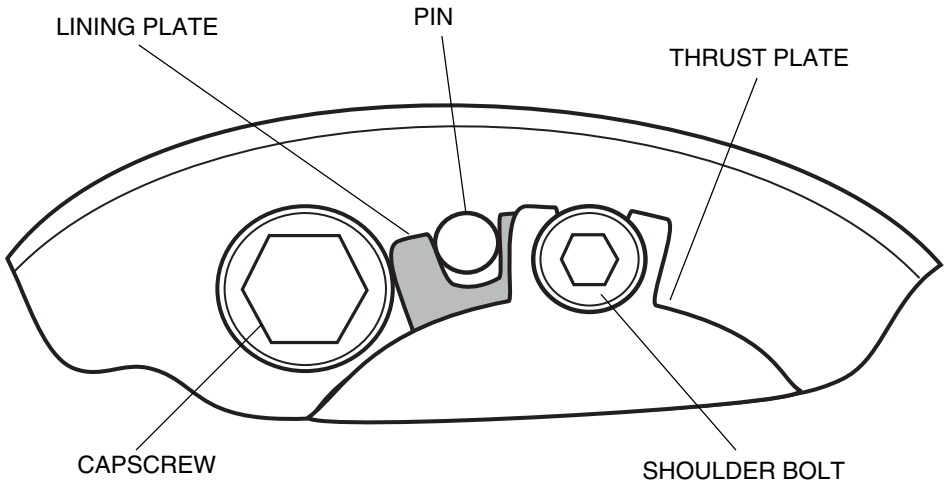


Fig. 5.14 Plate and Disc Alignment

c. Cleaning and Drying

1. Clean all parts with approved petroleum based cleaner.
2. Use clean lint free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.
3. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

d. Inspection and Replacement

1. If yoke shaft (Fig. 5.12) shows wear in the area of oil seal (14 and 17, Fig. 5.13) contact, replace it.
2. Replace all oil seals (16 and 17), O-rings (22 and 23), and back up rings (20 and 21) regardless of condition.
3. Replace bearing (14) if it is worn, pitted, or damaged.
4. Replace outer spline (3) if it is worn, pitted, scored, or chipped.
5. Replace all weak, broken, or damaged springs (4).
6. If any one of lining plates (9) or rotor discs (8) show wear or scoring, replace the complete stack.

NOTE: If a new stack wasn't installed, keep the stack of plates and discs in exactly the same order in which they were removed.

e. Assembly

Refer to page 55 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for assembly instructions.

f. Installation

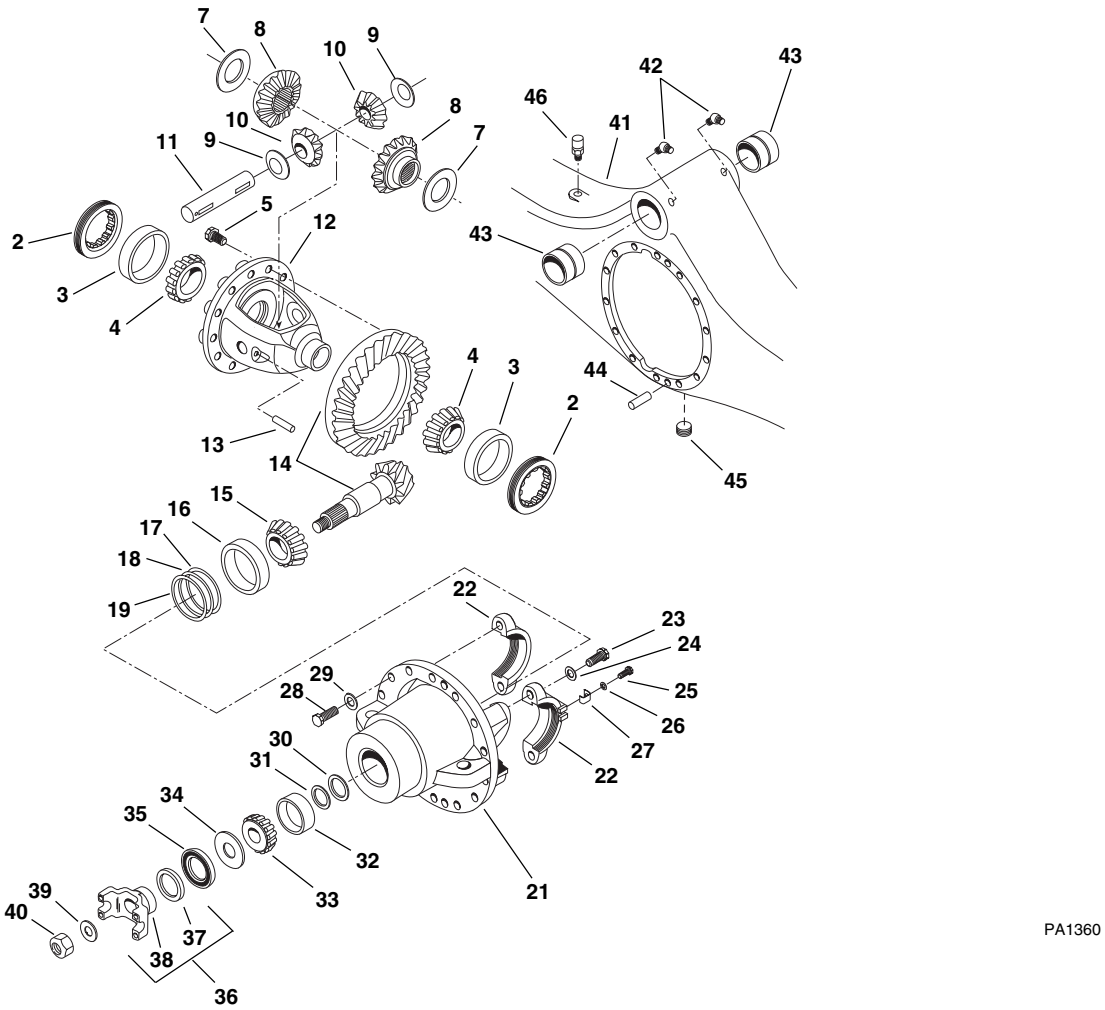
1. Install dust slinger (37, Fig. 5.16) on end yoke assembly (38).
2. Refer to page 54 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for installation instructions.

g. Bleeding

1. Be sure all pressure lines are secure and don't leak.
2. Bleed the pressure release section of the park lock by pressurizing the side inlet port and allowing air to escape from the top port.
3. Pressure should not exceed 100 psi (690 kPa) during bleeding.
4. Apply sufficient pressure to release the park lock and allow for the checking of system operation.

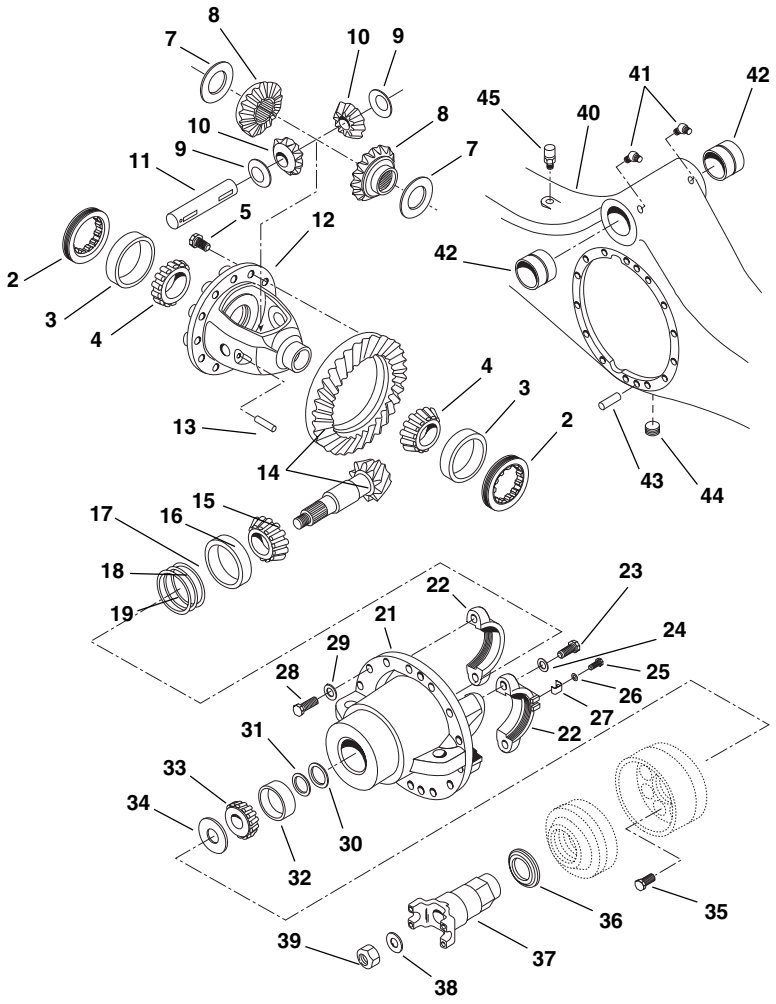
5.2.7 Carrier Assembly

Refer to paragraph 5.2.1 for axle assembly removal and installation instructions. Refer to pages 38 through 53 of Spicer® Dana Models PS/PR-7036 Maintenance Manual for removal and installation of carrier from axle housing; removal and installation of differential from carrier, and differential and pinion disassembly and assembly.



1. Differential Carrier Assembly (includes items 2 thru 40)
2. Ring, adjusting (2)
3. Cup, roller bearing (2)
4. Cone, roller bearing (2)
5. Screw, differential (12)
6. Differential Case Assembly (includes items 7 thru 13)
7. Washer, thrust (2)
8. Gear, differential side (2)
9. Washer, pinion thrust (4)
10. Gear, pinion (4)
11. Shaft, differential
12. Case, differential
13. Pin, pinion bearing cage
14. Gear and Pinion Assembly
15. Cone, roller bearing
16. Cup, roller bearing
17. Shim, bevel pinion bearing, 0.003" (AR)
18. Shim, bevel pinion bearing, 0.005" (AR)
19. Shim, bevel pinion bearing, 0.010" (AR)
20. Carrier Assembly (includes items 21 thru 24)
21. Carrier
22. Cap, differential carrier (2)
23. Screw, differential bearing cap (4)
24. Washer, differential bearing cap (4)
25. Bolt, hex (2)
26. Washer, flat (2)
27. Clip, adjusting ring (2)
28. Screw, hex hd cap (14)
29. Washer, flat (14)
30. Spacer, flat
31. Shim, adjusting (AR)
32. Cup, roller bearing
33. Cone, roller bearing
34. Washer, bearing thrust
35. Seal, oil
36. End yoke assembly (includes items 37 and 38)
37. Deflector
38. End Yoke
39. Washer, pinion nut
40. Nut, pinion
41. Housing, axle
42. Fitting, grease (2)
43. Bushing, axle pivot (2)
44. Pin, dowel (2)
45. Plug, pipe (2)
46. Vent

Fig. 5.15 Front Axle Differential Carrier Assembly



1. Differential Carrier Assembly (includes items 2 thru 39)
2. Ring, adjusting (2)
3. Cup, roller bearing (2)
4. Cone, roller bearing (2)
5. Screw, differential (12)
6. Differential Case Assembly (includes items 7 thru 13)
7. Washer, thrust (2)
8. Gear, differential side (2)
9. Washer, pinion thrust (4)
10. Gear, pinion (4)
11. Spider, differential
12. Case, differential
13. Pin, pinion bearing cage
14. Gear and Pinion Assembly
15. Cone, roller bearing
16. Cup, roller bearing
17. Shim, bevel pinion bearing, 0.003" (AR)
18. Shim, bevel pinion bearing, 0.005" (AR)
19. Shim, bevel pinion bearing, 0.010" (AR)
20. Carrier Assembly (includes items 21 thru 24)
21. Carrier
22. Cap, differential carrier (2)
23. Screw, differential bearing cap (4)
24. Washer, differential bearing cap (4)
25. Bolt, hex (2)
26. Washer, flat (2)
27 Clip, adjusting ring (2)
28. Screw, hex hd cap (14)
29. Washer, flat (14)
30. Spacer, flat
31. Shim, adjusting (AR)
32. Cup, roller bearing
33. Cone, roller bearing
34. Washer, bearing thrust
35. Bolt, hex (8)
36. Slinger, dust
37. End yoke assembly
38. Washer, pinion nut
39. Nut, pinion
40. Housing, axle
41. Fitting, grease (2)
42. Bushing, axle pivot (2)
43. Pin, dowel (2)
44. Plug, pipe (2)
45. Vent

Fig. 5.16 Rear Axle Differential Carrier Assembly

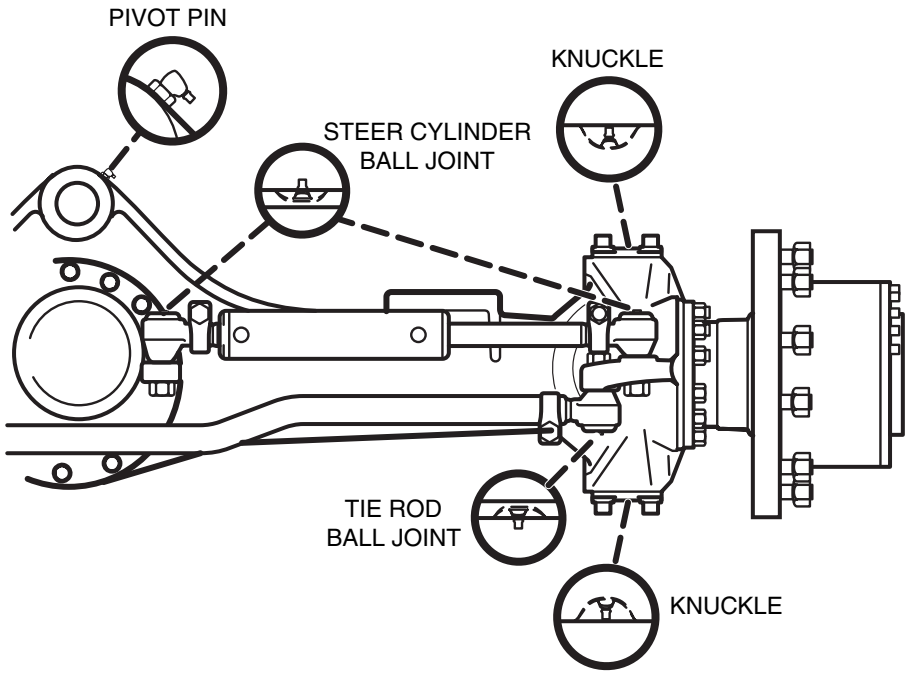


Fig. 5.17 Axle Grease Points

5.3 AXLE LUBRICATION

5.3.1 Grease

Lubricate the following axle points (Fig. 5.17) after overhaul or at 50 hour intervals using multi-purpose lithium-based grease:

- pivot pins (4 points)

Lubricate the following axle points (Fig. 5.17) after overhaul or at 250 hour intervals using multi-purpose lithium-based grease:

- steering knuckles (8 points)
- tie rod ball joints (4 points)
- steer cylinder ball joints (8 points)

5.3.2 Differential Housing Oil

Level Check (250 hour intervals)

1. Clean the area around the axle and remove the fill and level plug (Fig. 5.18) from the axle housing.
2. Check the oil level.
3. Add gear oil meeting military specification MIL-L2105C API classification GL-5 to the level of the plug hole. The oil should be a 90W or multi-grade 80W-90 with EP properties.

Warning !

- Do not attempt carrier and differential removal and installation and differential and pinion disassembly and assembly without thoroughly understanding instructions in Spicer® Dana publications and correspondence which applies to your forklift.
- If it becomes necessary to disassemble any parts inside the carrier, it is suggested that the entire axle be removed from the forklift and held tight in a stand or rack with carrier pinion positioned up.
- When removing axle assembly, make sure forklift is properly supported; an improperly supported vehicle can cause serious injury or death.
- If axle assembly is still in the forklift, be sure carrier, differential and pinion assemblies are securely supported before they are separated from the axle housing.

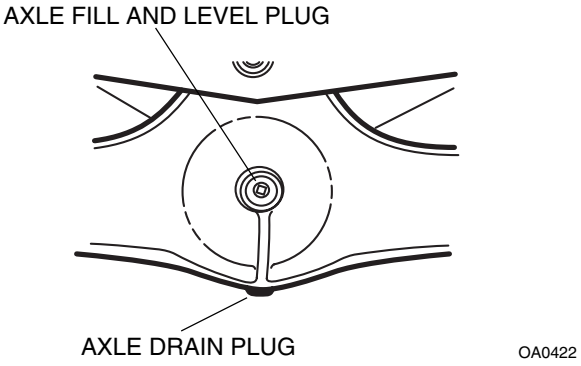


Fig. 5.18 Axle Fill and Drain Plugs

Change (1000 hour intervals)

1. Place a receptacle under the axle housing drain plug (Fig. 5.18).
2. Clean area around the axle fill and level plug and drain plug and remove both plugs.
3. Allow the oil to drain completely.
4. Install the drain plug.
5. Fill the axle with gear oil meeting military specification MIL-L2105C API classification GL-5 to the level of the level plug hole. The oil should be a 90W or multi-grade 80W-90 with EP properties. Axle capacity is 18 quarts (17 liters).
6. Install the fill and level plug.

5.3.3 Wheel End Brake Oil

Magnetic Plug Check (First 50 hours)

1. Level the forklift, ground the carriage, shut off the engine, and engage the park lock. Be sure that the arrow on the wheel end housing is pointing down (Fig. 5.19).
2. Clean the area around the magnetic drain plug and remove the plug.
3. Remove any metallic debris that may have collected on the end of the plug.
4. Reinstall the plug.

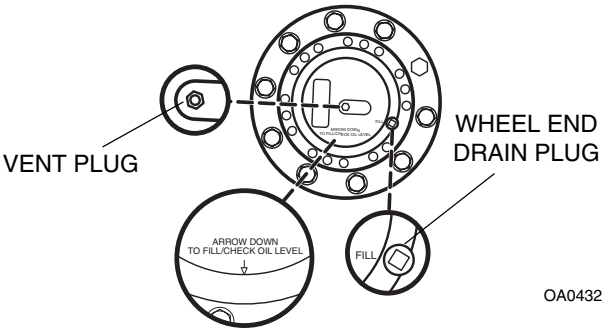


Fig. 5.19 Wheel End Drain and Vent Plugs

Level Check (250 hour intervals)

1. Level the forklift, ground the carriage, shut off the engine, and engage the park lock. Be sure that the arrow on the wheel end housing is pointing down (Fig. 5.19).
2. Clean the area around the magnetic drain plug and remove the plug.
3. Check the oil level and, if necessary, use only Special JLG Wet Disc Brake Oil P/N 8522042 as required to bring the level up to the plug hole.

IMPORTANT: *Other brake oils must not be used. If they are, loss of braking force and squealing will occur.*

4. Clean and install the magnetic drain plug.

Oil Change (1000 hour intervals)

1. Level the forklift, ground the carriage, shut off the engine, and engage the park lock. Be sure that the drain plug on the wheel end housing is pointing down (Fig. 5.15).
2. Remove the vent plug
3. Clean the area around the magnetic drain plug and remove the plug.
4. Allow the oil to drain.
5. Move the forklift so that the arrow on the wheel end housing is pointing up.
6. Fill the wheel end using only Special JLG Wet Disc Brake Oil P/N 8522042 as required to bring the level up to the drain plug hole. Capacity for the front wheel end is 54.0 ounces (1,6 liter) and for the rear wheel is 56.0 ounces (1,7 liter).
7. Clean and install the drain and vent plug.

5.4 SPECIFICATIONS

Oil Capacity of Differential Housing

18 qts (17 liters)

Gear oil MIL-L2105C

API classification GL-5

90W or multi-grade 80W-90 with EP properties:
- Amoco MP Gear Lube 80W90
- Benz Multi-Purpose 80W90
- Mobil Mobilube HD 80W90
- Shell Spirax 80W90
- Texaco Multi Gear Lube 80W90

Oil Capacity of Wheel End

Front-54 oz. (1,6 liter)

Special TRAK Wet Disc Brake Oil (P/N 8522042)

Rear-56 oz. (1,7 liter)

Special TRAK Wet Disc Brake Oil (P/N 8522042)

Park Lock Unit

Type:

Multiple Disc Park Lock, spring apply hydraulic release (dry disc design)

Maximum Speed:

1700 rpm

Release Pressure:

364 psi (2 512,0 kPa) min.

3000 psi (20 700,0 kPa) max.

Torque Rating:

17,000 in. lbs (19 210,0 N m) static (breakaway)

Volume displacement to release park lock:

1.2 cu. in. (19,6 cm)

Approximate Weight:

44 lbs (20 kg)

For use with mineral base hydraulic oil only.

NOTE: Refer to pages 59 and 60 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for additional specifications.

5.5 TROUBLESHOOTING

Troubleshooting instructions are provided on pages 56 through 59 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036.

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SECTION 6
DRIVE SHAFTS AND DROP BOX

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6.1 DRIVE SHAFTS

6.1.1 Drive Shaft Servicing

a. Removal

Drive Shaft–Transmission to Drop Gear Box

1. Remove the transmission cover from the forklift.
2. Remove the U-bolt assembly or bearing straps, Fig. 6.1, attaching the drive shaft cross assembly to the drop box input shaft yoke. Slide slip joint towards transmission so cross slips out of drop box input shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings do not drop off cross.

3. Remove the cap and bolt assembly or bearing straps securing the drive shaft cross assembly to the transmission output shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings do not drop off cross.

4. Remove the drive shaft assembly from the forklift.

Drive Shafts–Drop Gear Box to Axle

1. Provide a suitable support under the shaft.
2. Remove the U-bolt assemblies, Fig. 6.1, attaching the drive shaft cross assembly to the drop box output shaft yoke. Slide slip joint towards transmission so bearing cross slips out of the drop box output shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings do not drop off cross.

3. Remove the U-bolt assemblies securing the drive shaft cross assembly to the axle input shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings do not drop off cross.

4. Remove the axle drive shaft assembly from the forklift.

b. Disassembly

1. Using an approved nonflammable cleaning fluid, clean the drive shaft assembly, Fig. 6.1, with a brush. Wipe dry before disassembling.
2. Place the drive shaft assembly in a bench vise.
3. Pinch the ends of two retaining rings, Fig. 6.2, that secure the bearing cross assembly in the yoke with a pair of pliers and remove them from their grooves in the yoke.

NOTE: If the retaining ring does not readily snap out of the groove in the yoke, tap the end of the bearing cap lightly to relieve the pressure against the ring.

4. Using a soft round pin with a flat face about 1/32" (0.8 mm) smaller than the hole diameter in the yoke, drive on one end of the bearing assembly unit until the opposite bearing assembly comes out of yoke.
5. Turn the yoke over and tap the exposed end of cross until the opposite bearing assembly falls free.
6. Remove the cross from the yoke.
7. Repeat steps 2 thru 6 to remove cross and bearings on other end of drive shaft.
8. Mark the shaft and sleeve assembly so that it can be aligned properly when reassembled. Yokes at both ends of the drive shaft must be in the same plane to prevent excessive vibration.
9. Unscrew the dust cap and slide the sleeve assembly off the spline of the drive shaft.
10. Remove the dust cap, split retaining ring, and felt seal from the shaft assembly.

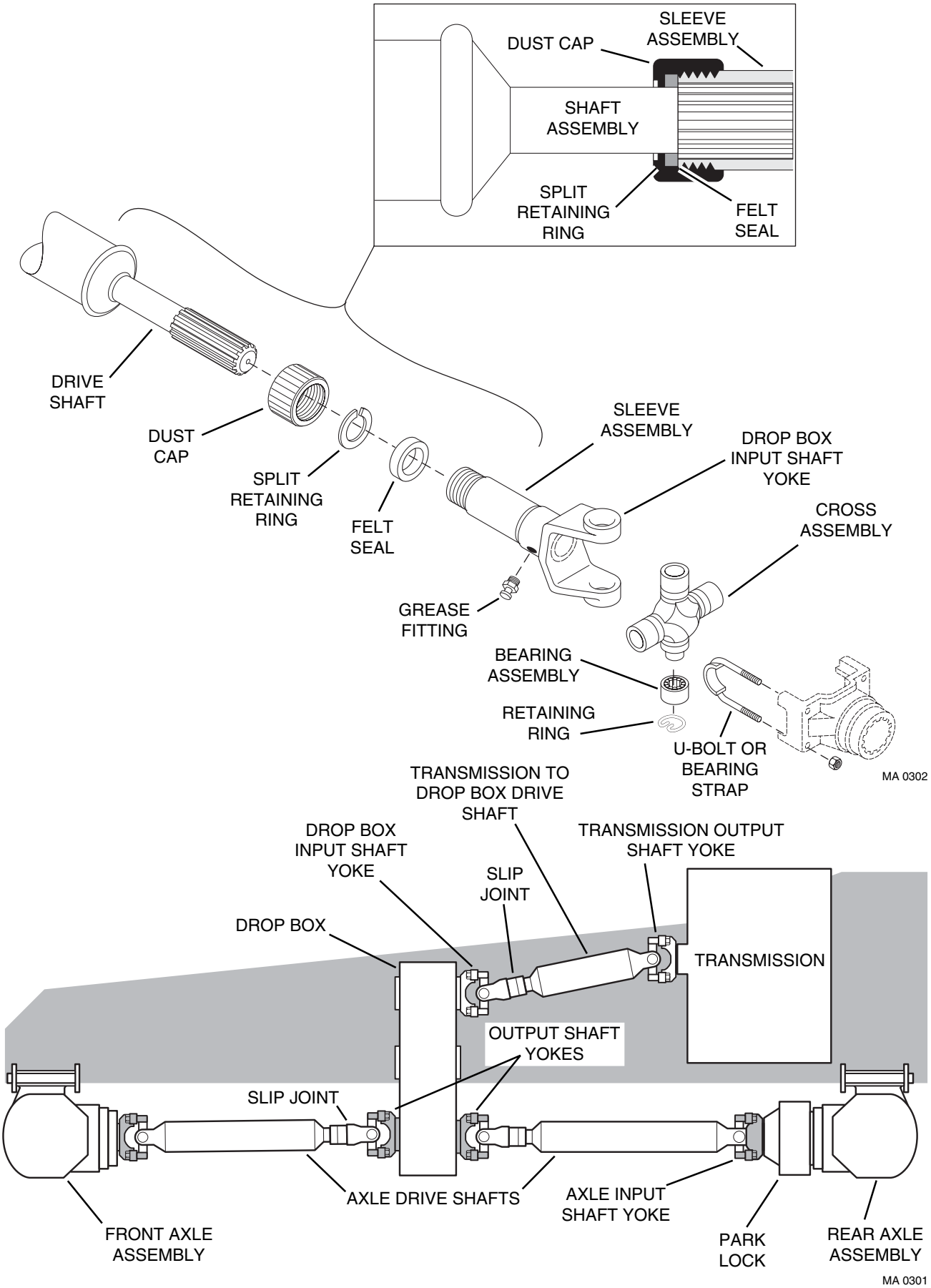

Fig. 6.1 Drive Shafts and Drop Box

c. Cleaning and Drying

1. Disassemble and clean all parts using an approved cleaning fluid.
2. Remove any burrs or rough spots from any machined surfaces.

d. Inspection and Replacement

1. Individually inspect each cross, bearing caps and needle bearings for signs of wear or missing parts.

NOTE: If all parts of the cross assemblies check to be in good condition, pack the bearing caps with a good grade of MP grease. Reassemble equal numbers of needle bearings into each cap and reassemble the cross assembly into the drive shaft yokes.

2. Replace the cross assembly as a complete assembly if any parts are worn or missing.
3. Replace the felt seal if worn or damaged.
4. Replace the sleeve or shaft assemblies if they are severely dented or damaged.
5. Cross assemblies should flex and be free from excessive bind. A slight drag is desirable on a new cross assembly. Excessive looseness causes unbalance.

e. Assembly

1. Install dust cap, Fig. 6.1, split retaining ring, and felt seal on the shaft assembly.
2. Slide the sleeve assembly onto the splines of the drive shaft and tighten the dust cap.

IMPORTANT: *Be sure that the arrows or marks on the shaft and sleeve assemblies are aligned, since the yokes on both ends of the drive shaft must be in the same plane to prevent excessive vibration.*

3. Install the cross and both bearings in the yoke.
4. Install the two retaining rings in their grooves in the yoke.
5. Repeat steps 3 and 4 for the other cross assembly.
6. Using the grease fitting on the sleeve assembly, lubricate the shaft assembly spline with a multi-purpose lithium-based grease.
7. Temporarily tape the two loose bearing caps to the cross so they do not fall off during assembly of drive shaft onto the forklift.

f. Installation

Drive Shaft–Transmission to Drop Gear Box

1. Position the drive shaft assembly on the forklift so slip joint mounts to the drop box, Fig. 6.1.
2. Remove tape and secure this end of the drive shaft cross assembly to the transmission output shaft yoke with a cap and bolt assembly or bearing straps. Torque the cap and bolt assembly to 30 to 35 lb-ft (41 to 48 N m) or the bearing strap to 55 to 60 lb-ft (75 to 82 N m).
3. Slide slip joints as far as possible onto drive shaft, remove taps and secure the drive shaft cross assembly to the drop box input shaft yoke with a U-bolt assembly or bearing strap. Torque the U-bolt assembly to 20 to 24 lb-ft (27 to 37 N m) or the bearing strap to 55 to 60 lb-ft (75 to 82 N m).
4. Install the transmission cover on the forklift.

Drive Shafts–Drop Gear Box to Axle

1. Position the drive shaft on supports under the fork lift so slip joint mounts to the drop box, Fig. 6.1.
2. Secure this end of the drive shaft cross assembly to the axle input shaft yoke with a U-bolt assembly. Torque the U-bolt assembly to 20 to 24 lb-ft (27 to 37 N m).
3. Slide slip joint as far as possible into drive shaft, remove tape and secure the drive shaft cross assembly to the drop box output shaft yoke with a U-bolt assembly. Torque the U-bolt assembly to 20 to 24 lb-ft (27 to 37 N m).
4. Remove supports from under the forklift.

6.2 DROP GEAR BOX

6.2.1 End Yokes

a. Inspection

Replace end yoke (3, Fig. 6.4) if worn or damaged.

b. Removal

To remove end yoke, remove screw (1, Fig. 6.4), washer (2) and end yoke (3).

c. Installation

To install end yoke, press yoke (3, Fig. 6.4) on shaft and secure with washer (2) and screw (1).

6.2.2 Oil Seals

a. Inspection

Replace oil seal (4, Fig. 6.4) if worn or damaged.

b. Removal

To remove oil seal, remove screw (1), Fig. 6.4, washer (2), end yoke (3) and oil seal (4).

c. Installation

1. To install oil seal, press oil seal and yoke on shaft.
2. Press yoke (3, Fig. 6.4) on shaft and secure with washer (2) and screw (1).

6.2.3 Internal Inspection

NOTE: JLG does not recommend servicing of gears, shafts or bearings inside this drop box. The drop box is manufactured in such a way that attempts at internal disassembly of these items may cause damage to other parts and possibly the drop box case. The only serviceable items of this drop box are the yokes and oil seals. If internal servicing of drop box is required while still under warranty, JLG recommends that the box be returned to the factory for rebuild or replaced with a new box. Out of warranty repairs or rebuilding may be performed at the customer's discretion; however, it is not an easy job.

a. Removal

1. Remove the transmission and hydraulic tank covers from the frame.
2. Remove the U-bolt assembly or bearing straps attaching the transmission drop gear box drive shaft cross assembly to the drop box input shaft yoke.
3. Remove the U-bolt assemblies attaching the axle drive shaft cross assemblies to the drop box output shaft yokes. Slide slip joint back as far as possible on drive shaft. Tape bearing caps to cross to prevent loss of bearings.
4. Secure drop gear box in a sling, connect sling to a hoist and remove slack from hoist line.
5. Drain hydraulic tank. Detach hose that runs between tank and drop box. Remove bolt and washer attaching input yoke to drop box.
6. From under the forklift, remove two capscrews and lock washers securing the box to the frame.
7. From above, remove the remaining two capscrews and lock washers attaching the drop box to the frame.
8. Use hoist to lift drop gear box from forklift.
9. Clean the exterior of the drop gear box and move it to a clean work area.

b. Installation

1. From above and below the frame, secure the drop gear box to the frame with four capscrews and lock washers. Torque capscrews 67.5 to 82.5 lb-ft (91.8 to 112.2 N m).
2. Remove the vent and level plugs.
3. Using vent plug opening, fill housing with tractor drop box fluid meeting specifications in paragraph 6.3 until it flows from the fluid level plug.
4. Install each plug securely.
5. Secure drive shaft cross assembly to drop box input shaft yoke with a U-bolt assembly or bearing strap. Torque U-bolt assembly to 20 to 24 lb-ft (27 to 37 N m) or the bearing strap to 55 to 60 lb-ft (75 to 82 N m).
6. Secure the drive shaft cross assemblies to the drop box output shaft yokes with a U-bolt assembly. Torque U-bolt assembly to 20 to 24 lb-ft (27 to 37 N m).
7. Install transmission and hydraulic tank covers on frame.

6.3 SPECIFICATIONS

Transmission and Drop Box–Use a Tractor Fluid which meets the requirements of any of the following specifications:

John Deere J20 A

Detroit Diesel C-3; C-2

Ford Tractor M2C134B

White Farm UTHF. Q1766, Q1722

Products known to meet these requirements include:

Texaco THD Oil

ARCO Tractor Fluid or equivalent

CAPACITIES:

Drop Box: 2.0 quarts (1.9 liter)

Transmission System (including filter and oil cooler): 3 gallons (13.7 liter)

Transmission Filter: 1 quart (0.95 liter)

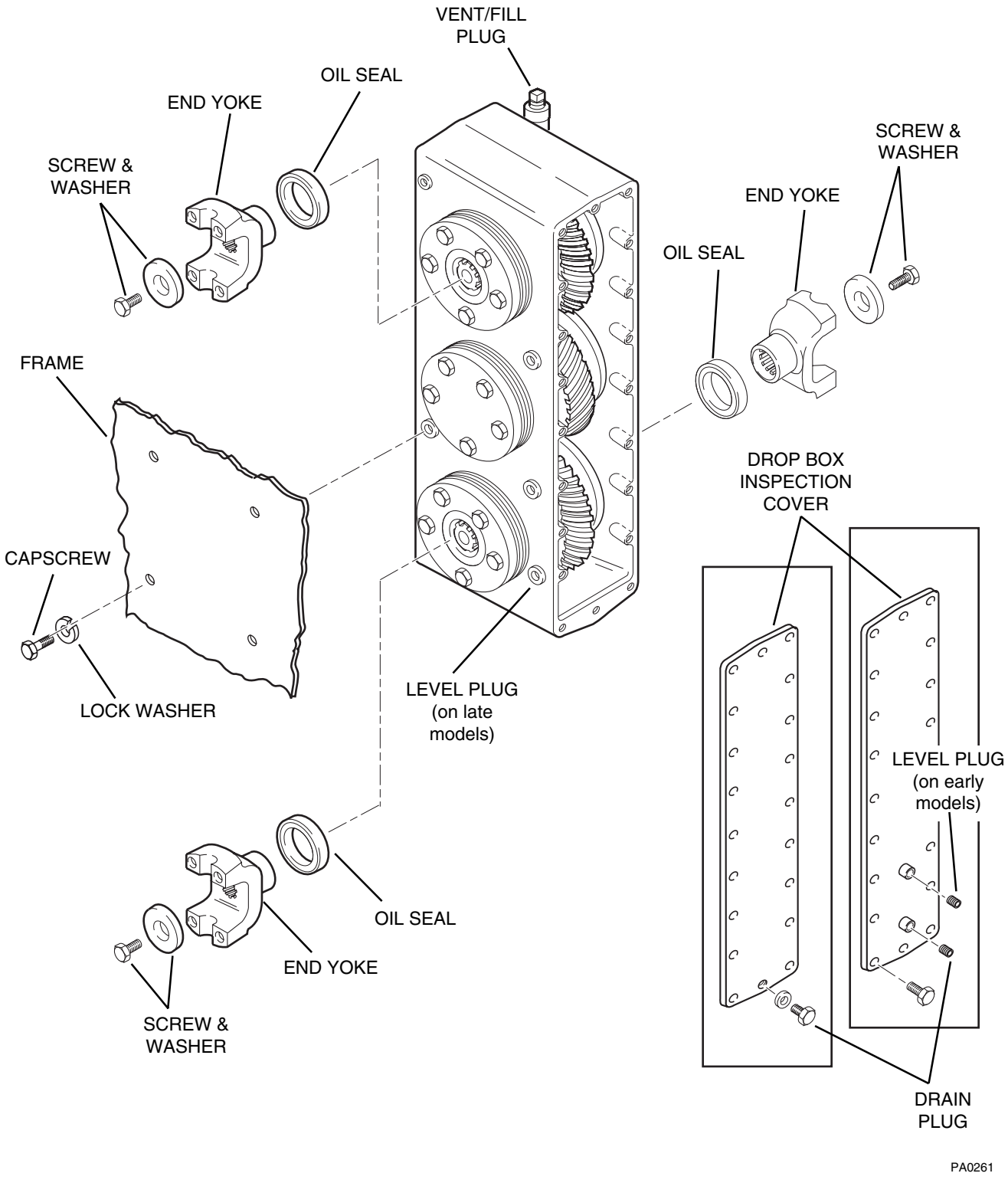

Fig. 6.2 Exploded View of Drop Gear Box

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SECTION 7
TRANSMISSION, CLARK SERIES 18000

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7.1 TRANSMISSION PREVENTIVE MAINTENANCE

Warning !

- To avoid severe burns, **DO NOT** attempt this procedure when the engine, cooling, and hydraulic systems are hot. Wait until they have cooled before proceeding.
- Care must be exercised to avoid skin rashes, fire hazards and inhalation of vapors when using solvent and alkali cleaners.
- Be careful when using steam cleaner to avoid burns.

IMPORTANT: *These instructions cover only the routine maintenance of the transmission. Refer to your 18000 Powershift Transmission Maintenance and Service Manual for transmission diagnosis, repair and component replacement. Cleanliness is of extreme importance. Before attempting any repairs, the exterior of the unit must be cleaned to prevent the possibility of dirt from entering the mechanism.*

7.1.1 Daily or 10 Hour Intervals

Level Check

1. Check the oil level with the engine running at idle, and oil at normal operating temperature.
2. Level the forklift, engage the parking lock, ground the carriage, and place the travel select lever in neutral.

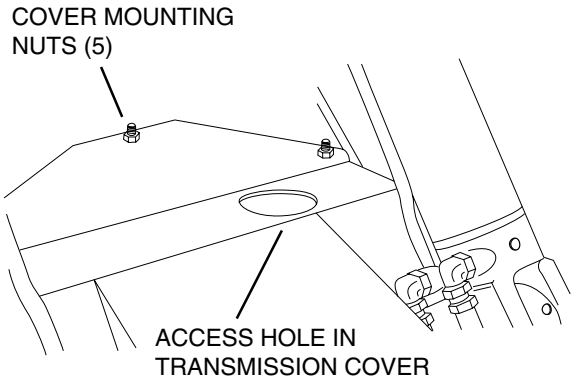


Fig. 7.1 Transmission Cover Access Hole

3. Remove the transmission dipstick through the access hole in the transmission cover, Fig. 7.1, and check the reading.
4. Add tractor hydraulic fluid to the transmission as required to being it up to the full mark. Transmission capacity is 4.3 gallons (16,3 liter).

7.1.2 First 50 Hours and 500 Hour Intervals Thereafter

Filter Change

1. Level the forklift, ground the carriage, shut off the engine, and engage the parking lock.
2. Remove the transmission cover from the top of the frame.
3. Place a receptacle under the transmission filter, Fig. 7.2, to catch fluid when the filter is removed.
4. Remove the old filter element and discard the element.
5. Apply a thin film of tractor hydraulic fluid to the new element gasket.

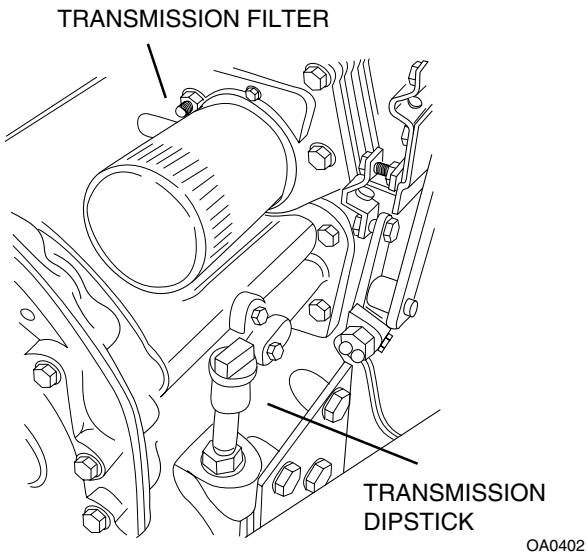


Fig. 7.2 Transmission Filter and Dipstick

6. Turn the element on the transmission fitting. Tighten the element to 20 to 25 lb-ft (27 to 34 N m).
7. Remove the receptacle.
8. Check the transmission level as instructed in the previous paragraph and add tractor hydraulic fluid as required.
9. Install the transmission cover on the frame.

7.1.3 1000 Hour Intervals

Fluid Change

1. Level the forklift, ground the carriage, shut off the engine, and engage the parking lock.
2. Place a funnel with a flexible drain and a receptacle under the transmission sump housing.

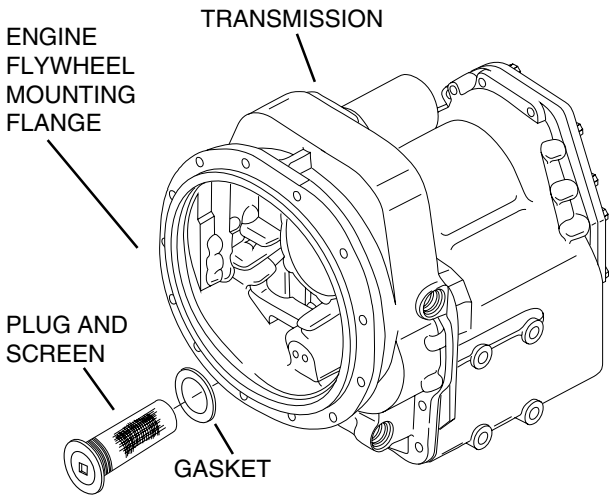


Fig. 7.3 Transmission Sump Plug and Screen

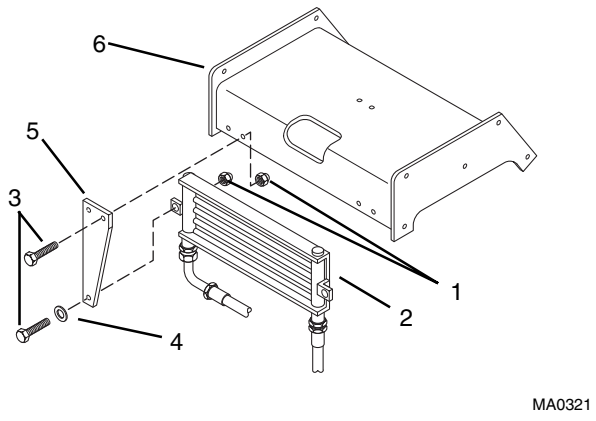
3. Remove sump plug and screen with gasket from housing, Fig. 7.3. Allow the transmission to drain completely.
4. Clean the plug and screen thoroughly with an approved solvent.
5. Install a new filter element as described in paragraph 7.1.2. DO NOT START ENGINE.
6. Install the cleaned drain plug and screen and gasket into the transmission sump housing.
7. Add tractor hydraulic fluid as required to bring fluid level up to full mark. Transmission capacity is 4.3 gallons (16,3 liter).

7.2 HOW TO TOW THE FORKLIFT

Before you tow the forklift for long distances be sure to disconnect and remove both front and rear drive lines to avoid damage to the transmission. Because of the design of the hydraulic system, the engine **cannot** be started by pushing or towing. For short distance towing consult your Owners/ Operators Manual.

7.3 HOW TO DRAIN TRANSMISSION

The procedure for drawing the transmission is described in paragraph 7.1.3.



1. Lock Nut
2. Transmission Oil Cooler
3. Capscrew, hex hd
4. Flat Washer
5. Oil Cooler Support
6. Rear Support

Fig. 7.4 Transmission Oil Cooler

7.4 HOW TO BACK FLUSH OIL COOLER

The transmission oil cooler, Fig. 7.4, is mounted behind the radiator. Periodically disconnect and back flush the oil cooler with oil and compressed air until all foreign material has been removed. If necessary, remove oil cooler from forklift and clean it using oil, compressed air and steam.

***IMPORTANT: DO NOT** use flushing compounds for cleaning purposes.*

7.5 TRANSMISSION REMOVAL

Please refer to paragraph 8.6 for engine and transmission removal instructions (they are removed as a single unit).

7.6 TRANSMISSION REPLACEMENT

If the transmission is to be replaced as a complete assembly, detach and transfer the following:

- Tandem Pump
- Transmission Temperature Switch
- Transmission Connector Kit (from valve)
- Two Side Mount Brackets
  (Neutral Start Switch comes with new transmission)

7.7 INTERNAL SERVICING

If servicing the transmission internally, the tandem pump may require removal for disassembly.

Refer to the enclosed "Clark 18000 Powershift Transmission Maintenance and Service Manual" when servicing the transmission internally.

7.8 INSTALLATION

Please refer to paragraph 8.8 for engine and transmission installation instructions (they are installed as a single unit).

7.9 TROUBLESHOOTING

Trouble	Probable Cause	Remedy
Low Clutch Pressure	Low oil level	Fill to proper level
	Clutch pressure regulating valve stuck open	Clean valve spool and housing
	Faulty charge pump	Replace pump
	Broken or worn clutch shaft or piston sealing rings	Replace sealing rings
	Clutch piston bleed valve stuck open	Clean bleed valve thoroughly
Low Converter Charging Pump Output	Low oil level	Fill to proper level
	Suction screen plugged	Clean suction screen
	Defective oil pump	Replace pump
Overheating	Worn oil sealing rings	Remove, disassemble, and rebuild converter assembly
	Worn oil pump	Replace pump
	Low oil level	Fill to proper level
Noisy Converter	Worn oil pump	Replace pump
	Worn or damaged bearings	Disassemble converter to determine what bearing is faulty
Lack of Power	Converter stalls because of low engine rpm	Tune engine and check governor
	Worn oil sealing rings	Remove, disassemble, and rebuild converter assembly
	Worn oil pump	Replace pump
	Low oil level	Fill to proper level

7.10 SPECIFICATIONS

System Capacity (inc. filter and oil cooler)	4.3 gallons (16,3 liter)
Filter Capacity	1 quart (0,95 liter)
Tractor Fluid	John Deere J20 A Detroit Diesel C-3, C-2 Ford Tractor M2C134B White Farm UTHF Q1766, Q1722
Converter: Outlet oil temperature	180 to 200 °F (82 to 93 °C) Transmission in Neutral.
Outlet pressure	25 psi (1,72 bar) minimum pressure at 2000 rpm engine speed 70 psi (4,82 bar) outlet pressure with engine operating at no-load governed speed.
Controls	Forward and Reverse is Manual Speed Selection is Manual
Clutch Type	Multiple discs, hydraulically actuated, spring released, automatic wear compensated, and nonadjustable. Oil cooled and lubricated. Inner Disc–Friction Outer Disc–Steel
Oil Filtration	Full flow oil filter safety bypass. Strainer screen in sump at bottom of transmission case.
Clutch Pressure	180 to 220 psi (12,40 to 15,16 bar) with: • park lock set (Never use service brakes) • oil temperature at 80 to 200 °F (82 - 93 °C) • engine at idle (400 to 600 rpm) Shift thru direction and speed clutches. All clutch pressure must be equal within 5 psi (0,34 bar). If clutch pressure varies in any one clutch by more than 5 psi (0,34 bar), repair the clutch.

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SECTION 8
ENGINE, PERKINS SERIES 4.236 AND T4.236

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Disclaimer and Scope of these Instructions

These instructions are written for world wide use. In territories where legal requirements govern engine smoke emission, noise, safety factors etc., then all instructions, data and dimensions given must be applied in such a way that, after servicing (preventive maintenance) or repairing the engine, it does not contravene the local regulations when in use.

Throughout this section, the left or right side of the engine is the side of the engine when viewed from the flywheel end.

Warning !

Observe these and many other precautions:

- Do not smoke during refueling
- Do not refuel with engine operating
- Do not permit loose clothing, long hair etc. near parts which move
- Never clean, lubricate or adjust engine during operation without correct training
- Keep away from parts which rotate; fans can be invisible when rotating
- Be sure engine operation will not cause a concentration of toxic emissions
- Persons in area must be kept clear during engine and forklift operation
- Guards must be installed when running
- Do not remove radiator cap while engine is hot; coolant is hot, under pressure and dangerous and can cause severe burns
- Relieve pressure in fuel and hydraulic systems before servicing; get medical assistance immediately if your skin comes in contact with high pressure fuel or hydraulic fluid
- Diesel fuel can cause skin damage to some persons; use gloves or special skin protection solutions
- Do not use salt water or other corrosive liquid in cooling system
- Keep sparks and fire away from batteries
- Battery fluid can burn and is dangerous to the skin and especially the eyes
- Some of the gaskets used on the engine contain asbestos. Breathing asbestos dust is dangerous to health and may cause serious bodily harm. Avoid creating dust and follow local directives for handling and disposing of materials which contain asbestos.
- Disconnect negative battery terminals before repairing electrical system
- Only one person must be in control of engine; forklift brakes must work
- Make only adjustments you understand.

IMPORTANT: *These instructions cover only the routine maintenance of the engine. Refer to your Perkins Engine Distributor for engine diagnosis, repair and component replacement.*

A gradual running in of a new engine is not necessary. Full load can be applied to a new engine as soon as the engine is put into service and the coolant temperature is at least 140 °F (60 °C). Extended light load operation during the early life of the engine is not recommended. Do not run engine at high no load speeds. Do not apply an overload to the engine.

Standard Maintenance Practices

It is assumed that gaskets will be replaced and gasket faces will be cleaned, where applicable.

It is understood that in reassembly and inspection, all parts are to be thoroughly cleaned, and where present, burrs and scale are to be removed.

It follows that any open ports of high precision components such as fuel system equipment, exposed by removal or disassembly, will be covered until reassembled to prevent the entry of foreign material.

Use a suitable sealant such as Loctite® when installing screws into " through" holes into the interior of the engine.

NOTE: Screw threads which have been sealant coated can be identified by their red or blue etc. color.

Unified Threads

All threads used on the engine are Unified Series and American Pipe Series.

Unified threads are not interchangeable with BSF and although BSW have the same number of threads per inch as Unified Coarse Series, interchanging is not recommended, due to a difference in thread form.

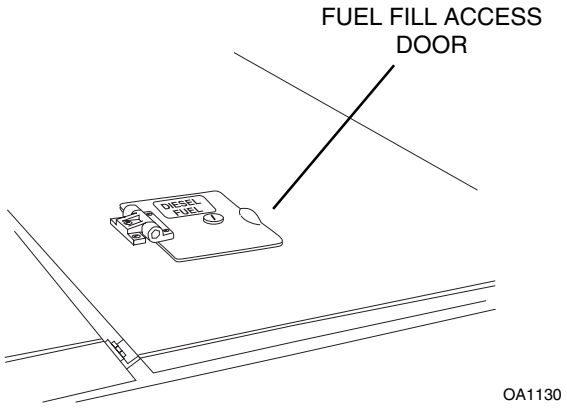


Fig. 8.1 Fuel Fill Access Door

8.1 ENGINE PREVENTIVE MAINTENANCE

8.1.1 Daily Before Operation

1. Open fuel fill access door with a key, Fig. 8.1.
2. Remove fill cap on fuel tank and fill with No. 2 Diesel Fuel as required. Tank capacity is 24 gallons (90 liter).
3. Install fill cap and lock access door.

8.1.2 First 50 Hours and 250 Hours Thereafter

NOTE: Refer to paragraph 8.1.9 for 25 or 50 hour Post Delivery Check.

Fan Belt Tension

1. Lower carriage to ground, shut off engine, and engage park lock.
2. Unlock and open left rear engine access door.
3. Inspect the fan belt. Replace a cracked or frayed belt.

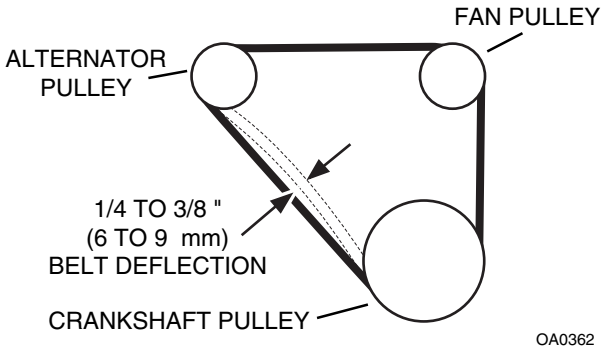


Fig. 8.2 Fan Belt Deflection

4. Check fan belt tension midway between the crankshaft and alternator pulleys, Fig. 8.2. Deflection should be 1/4 to 3/8" (6 to 9 mm) with an applied force of 13 to 15 lbs. (6 to 7 kg).
5. If belt deflection exceeds the tolerance, loosen both alternator mounting screws. Carefully pry the alternator to tighten the belt and, at the same time, tighten the alternator screws. Recheck belt deflection.
6. Close and lock the left rear engine access door.

8.1.3 Daily or 10 Hour Intervals

Air Cleaner

1. Lower carriage to ground, shut off engine, and engage park lock.

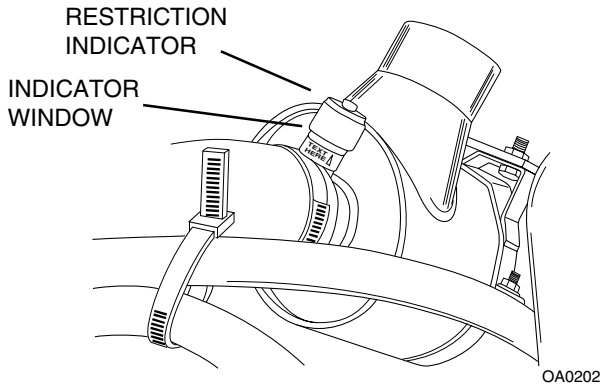


Fig. 8.3 Air Cleaner Restriction Indicator

2. Unlock and open left rear engine access door. Check air cleaner restriction indicator, Fig. 8.3. If red band has appeared, the primary element must be cleaned or replaced (steps 4 thru 8).

NOTE: *Momentarily press reset button on top of indicator after you service element.*

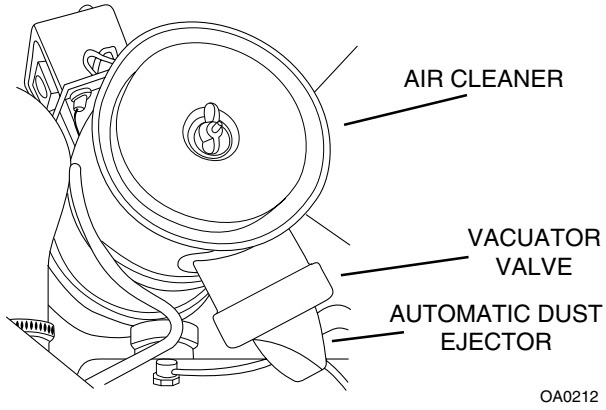


Fig. 8.4 Vacuator Valve

3. Unlock and open the right rear engine access door. Remove dust and dirt from the vacuator valve, Fig. 8.4. Lips of automatic dust ejector must close but not adhere together.

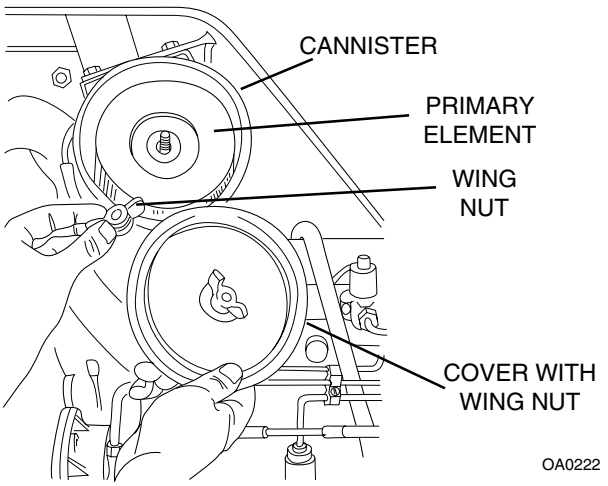


Fig. 8.5 Air Cleaner Primary Element

4. Remove the air cleaner cover wing nut, cover, and primary element, Fig. 8.5.

Warning !

Wear safety glasses when using compressed air to clean element.

5. Clean the primary element with compressed air or by washing.
   - If using compressed air: direct no more than 100 psi (6,9 bar) into the element. Move the nozzle up and down while rotating the element.
   - If washing: soak the element for 15 minutes in a non-foaming detergent and water solution. Rinse until the water is clear. Air dry. DO NOT use compressed air to dry the element.
6. Carefully inspect the primary element for tears and holes.
7. Thoroughly clean inside the primary element cannister.
8. Replace the primary element after six cleanings or annually.

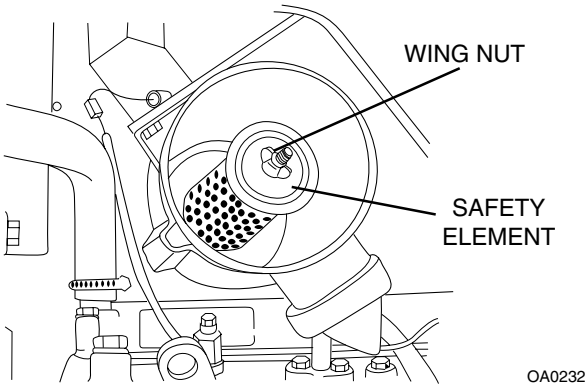


Fig. 8.6 Air Cleaner Safety Element

9. After you replace three primary elements, install a new safety element, Fig. 8.6. DO NOT clean the safety element.

IMPORTANT: *Make sure the primary element cannister is thoroughly cleaned before removing the safety element. Dirt could enter the intake manifold and cause internal engine damage.*

10. Install the air cleaner cover and wing nut. Be sure the wing nut is tight.
11. Check all hose connections at this time.
12. Close and lock access doors.

Engine Coolant

1. Level the forklift, lower carriage to ground, shut off engine and engage park lock.
2. Unlock and open the right rear engine access door.

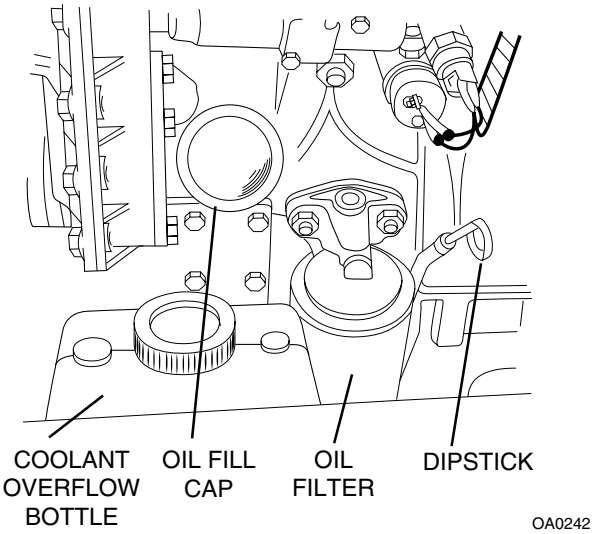


Fig. 8.7 Coolant and Engine Oil

3. Check the level of coolant in the overflow bottle, Fig. 8.7. When the coolant is hot, the bottle should be 3/4 full to full. When the coolant is cool, the bottle should be 1/4 to 1/2 full.
4. Add coolant as required through the overflow bottle. Use a 50/50 mixture of ethylene glycol and water.
5. Close and lock the right rear engine access door.

Engine Oil Level

1. Level the forklift, lower the carriage to ground, shut off engine, and engage park lock.
2. Unlock and open the right rear engine access door.
3. Remove the engine oil dipstick, Fig. 8.7, and check the level. Oil should be between the full and add mark. Replace dipstick.
4. If required, add 10W30 motor oil equal to API, SE CC, or SE CD Specifications.
5. Close and lock the right rear engine access door.

8.1.4 250 Hour Intervals

Engine Oil and Filter Change

1. Operate the engine until it is warm (approximately 5 minutes).
2. Level forklift, lower the carriage to ground, shut off engine, and engage park lock.
3. Place a receptacle under the engine oil pan drain plug.
4. Remove drain plug on rear face of the engine oil pan and allow oil to drain completely into receptacle.
5. Unlock and open the right rear access door.
6. Remove the oil filter, Fig. 8.7. A strap or chain filter wrench may be required.
7. Clean the filter sealing surface.
8. Apply a thin coat of engine oil to the seal on a new filter.
9. Install new oil filter and tighten 1/2 turn after initial contact.
10. Clean and install the oil pan drain plug.
11. Remove oil fill cap, Fig. 8.7, and add 10W30 motor oil equal to API, SE CC, or SE CD specifications (refer to paragraph 8.1.10). DO NOT overfill. Crankcase capacity with filter is 9.4 quarts (8,9 liter).
12. Start the engine and run for several minutes.
13. Stop the engine and allow oil to drain back for a few minutes.
14. Check dipstick and add oil as required.
15. Check for leaks at the filter and drain plug. Retighten either if necessary.
16. Add oil to bring level to full mark on dipstick.
17. Close and lock engine access door.

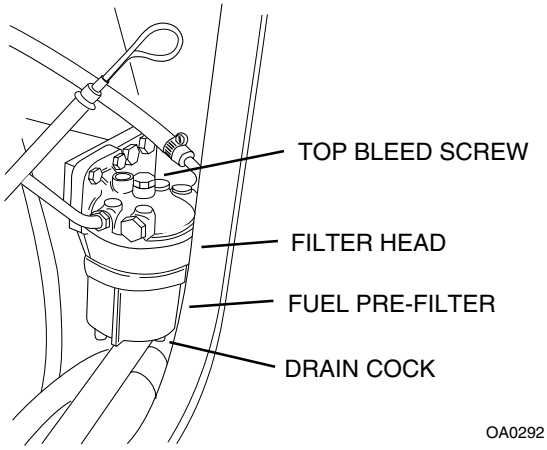


Fig. 8.8 Fuel Pre-Filter

Fuel Pre-Filter

1. Unlock and open right rear access door.
2. Open top bleed screw of fuel pre-filter, Fig. 8.8.

3. Loosen drain cock on bottom of fuel pre-filter and allow water to completely drain from it.
4. Tighten the drain cock and top bleed screw after draining.
5. Close and lock the right rear engine access door.

Fan Belt Tension

1. Lower carriage to ground, shut off engine, and engage park lock.
2. Unlock and open the left rear engine access door.
3. Inspect the fan belt. Replace a cracked or frayed belt.
4. Check fan belt tension midway between the crankshaft and alternator pulleys, Fig. 8.2. Deflection should be 1/4 to 3/8" (6 to 9 mm) with an applied force of 13 to 15 lbs. (6 to 7 kg).
5. If belt deflection exceeds the tolerance, loosen both alternator mounting screws. Carefully pry the alternator to tighten the belt and, at the same time, tighten the alternator screws. Recheck belt deflection.
6. Close and lock the left rear engine access door.

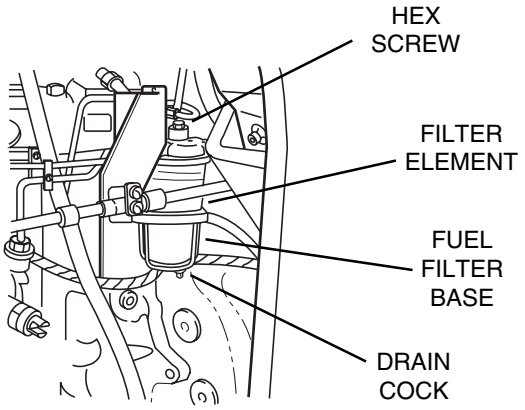


Fig. 8.9 Fuel Filter

8.1.5 500 Hour Intervals

Fuel Filter

1. Unlock and open the right rear engine access door.
2. Remove screw in top of the filter assembly, Fig. 8.9.
3. Remove filter base and discard element.
4. Clean base and head.
5. Position a new filter element between the base and head and install and tighten screw on top of filter assembly until snug.
6. Remove air from the fuel system. (See paragraph 8.4.8, How to Bleed to Fuel System).
7. Close and lock the right rear engine access door.

Fuel Lift Pump Sediment Chamber

1. Unlock and open the left rear engine access door.

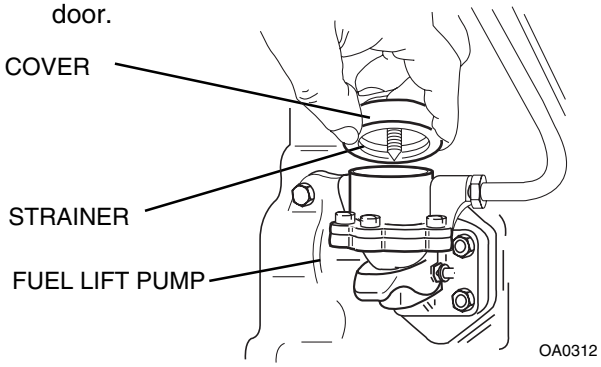


Fig. 8.10 Fuel Lift Pump

2. Remove fuel lift pump cover and strainer, Fig. 8.10.
3. Wash any sediment from the lift pump and clean the cover and strainer.
4. Install the cover making sure that it seats on the pump with NO leakage.
5. Remove air from the fuel system. (See paragraph 8.4.8, How to Bleed to Fuel System).
6. Close and lock the left rear engine access door.

NOTE: Marginal fuel cleanliness conditions will require fuel system service more frequently. Loss of engine power is often caused by dirty fuel filters.

Bleeding Fuel System

Air must be vented from the fuel system whenever any part of the system between the fuel tank and injection pump has been disconnected for any reason, or when the system has been emptied of fuel.

IMPORTANT: *DO NOT start the engine until the injection pump has been filled and primed as the pump can be seriously damaged due to lack of lubrication.*

Remove air from the fuel system as follows:

NOTE: More than one person may be required to perform this procedure.

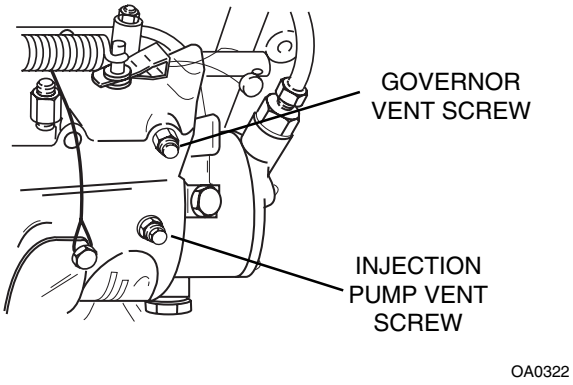


Fig. 8.11 Vent Screws in Injection Pump

1. Unlock and open the right rear engine access door. Loosen the governor vent screw in the fuel injection pump governor control cover, Fig. 8.11.
2. Loosen the injection pump vent screw on the side of the fuel injection pump.

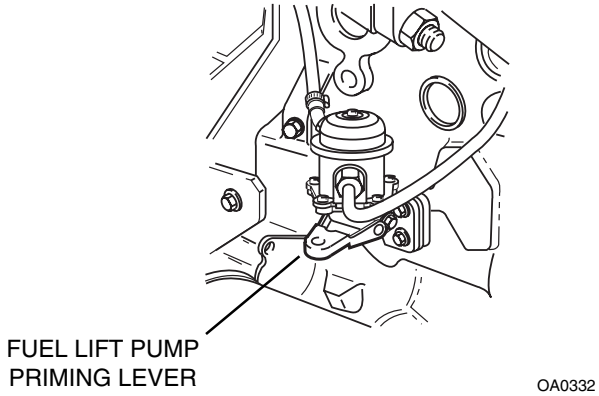


Fig. 8.12 Priming Lever

3. Unlock and open the left rear engine access door. Operate the priming lever on the fuel lift pump, Fig. 8.12, until fuel, free of air, comes from both vents.

NOTE: If the fuel lift pump cam is on maximum lift, it will not be possible to operate the priming lever. The engine should be turned over momentarily to reposition the lift pump cam.

4. Continue to pump fuel and close the vents in the following order:
   - Injection pump vent screw
   - Governor vent screw

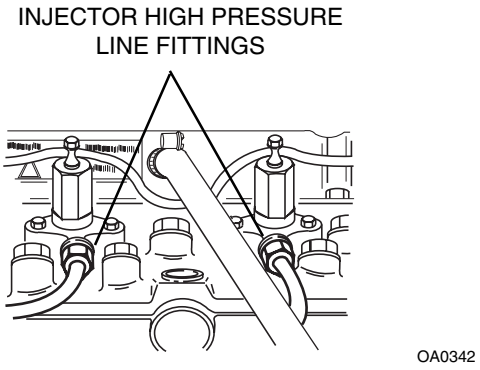


Fig. 8.13 Injector High Pressure Line Fittings

5. Loosen any two high pressure fittings, Fig. 8.13, that come from the fuel injection pump. Loosen these fittings at the base of the injectors. Also loosen the fitting of the Thermo Start fuel line in the intake manifold, Fig. 8.14.

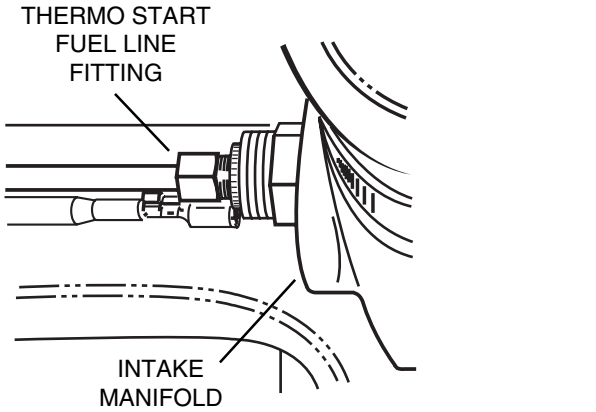


Fig. 8.14 Thermo Start Fuel Line Fitting

6. Turn the ignition key to the START position and operate the starter until fuel, free from air, comes from the injector and Thermo Start fuel line fittings. Turn ignition switch OFF. Tighten all fittings.
7. Close and lock both access doors. The engine is now ready to start.

If the engine runs correctly for a short time and then stops or runs roughly, check for air in the fuel system. If there is air in the fuel system, there is probably a leak in the low pressure system.

8.1.6 1,000 Hour Intervals

1. Replace fuel filter element.
2. Clean sediment chamber of fuel lift pump.
3. Clean or replace element of dry type air cleaner, if not indicated earlier.

8.1.7 2,500 Hour Intervals

1. Inspect and service proprietary equipment such as starter motor, alternator, turbocharger (if applicable) etc.
2. Service atomizers (fuel injectors), para. 8.4.9.
3. Check and adjust valve tip clearances, para. 8.10.

8.1.8 Annually

Engine Coolant Change

Warning !

- To avoid severe burns, DO NOT attempt this procedure when engine is hot. Wait for engine, muffler, and tail pipe to cool before proceeding.
- To prevent personal injury, never remove the radiator cap while the cooling system is hot. The system is under pressure and coolant can cause severe burns and eye injury. Wear safety glasses. Always turn the cap slowly to the first stop and allow the pressure to escape before removing cap completely.

1. With forklift on level ground, unlock and open the left rear engine access door.
2. Remove radiator cap.

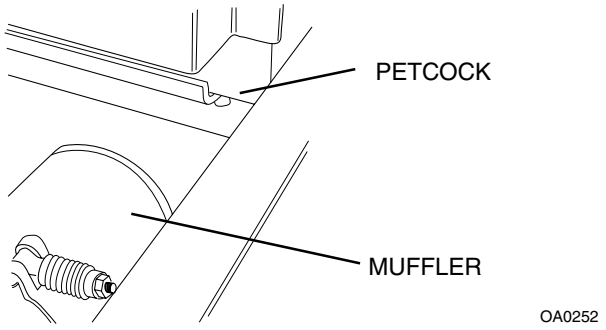


Fig. 8.15 Radiator Petcock

3. Attach a hose to petcock at bottom left corner of radiator, Fig. 8.15, to allow draining directly into a container. Open petcock and drain the coolant from the radiator.

NOTE: If engine is turbocharged, drain oil cooler in lubricating oil filter by removing inlet or outlet connections, flush cooler and reconnect hose.

4. Detach the line from the bottom of the coolant overflow bottle and allow the bottle to drain.
5. Flush the system with clean water.

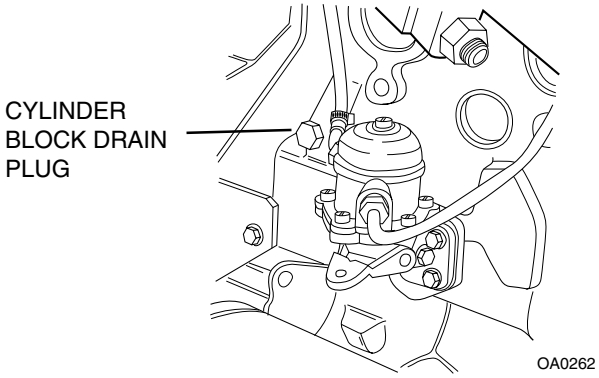


Fig. 8.16 Cylinder Block Drain Plug

6. Remove cylinder block drain plug, Fig. 8.16, and drain engine block. Replace drain plug.
7. Connect line to overflow bottle and close the petcock on the radiator.
8. Refer to paragraph 8.2.1 and fill radiator with 5.4 gallons (20,4 liter) of coolant.
9. Replace the radiator cap. Add coolant to overflow bottle until bottle is 1/4 to 1/2 full—approximately 1 qt (0,9 liter).

Air Filter Primary Element Change

Replace air filter primary element, Fig. 8.5, after six cleanings or annually.

8.1.9 Post Delivery Check

After 25 to 50 hours of operation or 500 to 1,000 miles (800 to 1600 km):

1. Run the engine until warm. Stop engine and drain lubricating oil from sump. Fill sump to the "full" mark on the dipstick with clean new lubricating oil of the approved grade.
2. Replace the canister of the lubricating oil filter.
3. Tighten the cylinder head nuts and capscrews as specified in paragraph 8.9.
4. Adjust valve tip clearances as described in paragraph 8.10.
5. Check that the intake and exhaust manifold nuts are tight.
6. Check tension of alternator/water pump drive belt as described in paragraph 8.1.2.
7. Check the atomizers as described in paragraph 8.4.9.
8. Check that all fasteners are tight.
9. Run the engine and check for fuel, coolant and lubricating oil leakage.
10. If necessary, have the idle speed adjusted as recommended in paragraph 8.4.7.f.

8.1.10 Lubricating Oils

Lubricating oils for naturally aspirated engines should meet the requirements of U.S. Ordnance Specification MIL-L-46152 or MIL-L-2104C.

Lubricating oils for turbocharged engines should meet U.S. Ordinance Specification MIL-L-2104C.

Do not use a lubricating oil to the MIL-L-2104C specification in naturally aspirated engines for the first 500 to 1,000 miles (25 to 50) hours of operation.

Lubricating oils for use in Perkins Diesel Engines should have a minimum viscosity index of 80. Some of these oils are listed below. Any other oils which meet these specifications are also suitable.

MIL-L-46152 Oils		S.A.E. Designation		
Company	**Brand**	0 °F (-18 °C) to 30 °F (-1 °C)	30 °F (-1 °C) to 80 °F (27 °C)	Over 80 °F (27 °C)
Castrol Ltd.	Castrol/Deusol CRX	10W	20	30
	Castrol/Deusol CRX	10W/30	10W/30	10W/30
	Castrol/Deusol CRX		20W/50	20W/50
	Deusol RX Super		20W/40	20W/40
Esso Petroleum Co. Ltd.	Essolube XD-3	10W	20W	30
	Essolube XD-3		15W/40	10W/30
Mobil Oil Co. Ltd.	Delvac 1200 Series	1210	1220	1230
	Delvac Special	10W/30	10W/30	10W/30
Shell	Rimula X	10W	20W/20	30
	Rimula X	10W/30	10W/30	10W/30
	Rimula X		15W/40	15W/40
	Rimula X		20W/40	20W/40
	Rotella TX	10W	20W/20	30
	Rotella TX		20W/40	20W/40

MIL-L-2104C Oils		S.A.E. Designation		
Company	**Brand**	0 °F (-18 °C) to 30 °F (-1 °C)	30 °F (-1 °C) to 80 °F (27 °C)	Over 80 °F (27 °C)
Castrol Ltd.	Castrol/Deusol CRD	10W	20	30
	Deusol RX Super		20W/40	20W/40
	Agricastrol HDD	10W	20	30
	Agricastrol MP		20W/30	20W/30
	Agricastrol MP		20W/40	20W/40
Esso Petroleum Co. Ltd.	Essolube D-3HP	10W	20W	30
	Essolube XD-3	10W	20W	30
	Essolube XD-3		15W/40	15W/40
Mobil Oil Co. Ltd.	Delvac 1300 Series	1310	1320	1330
Shell	Rimula CT	10W	20W/20	30
	Rimula X	10W	20W/20	30
	Rimula X	10W/30	10W/30	10W/30
	Rimula X		15W/40	15W/40
	Rimula X		20W/40	20W/40
	Rotella TX	10W	20W/20	30
	Rotella TX		20W/40	20W/40

8.2 ENGINE COOLING SYSTEM

The engine cooling system consists of coolant passages in the engine, a thermostat, pump, hoses, a radiator and a radiator overflow tank.

The engine is cooled by the circulation of coolant through passages in the cylinder block and head. Circulation is by thermo-syphon action assisted by an impeller type water pump driven by a V-belt from the crankshaft pulley.

The water pump bearings are pre-packed with a special grease during assembly and do not require attention in service.

8.2.1 Coolant Requirements

The quality of coolant will determine the efficiency and life of the cooling system.

- DO NOT USE HARD WATER in the cooling system. Hard water, or water with high levels of calcium and magnesium ions, encourages the formation of silica gel formations, especially after a number of heating and cooling cycles. These gel formations can result in loss of cooling or heating in radiators and cab heater cores by coating and plugging the tubes. It usually deposits in the cooler section of the cooling system, such as the radiator bottom tank.
- USE DISTILLED WATER OR DEIONIZED WATER to reduce the potential and the severity of silicate dropouts.

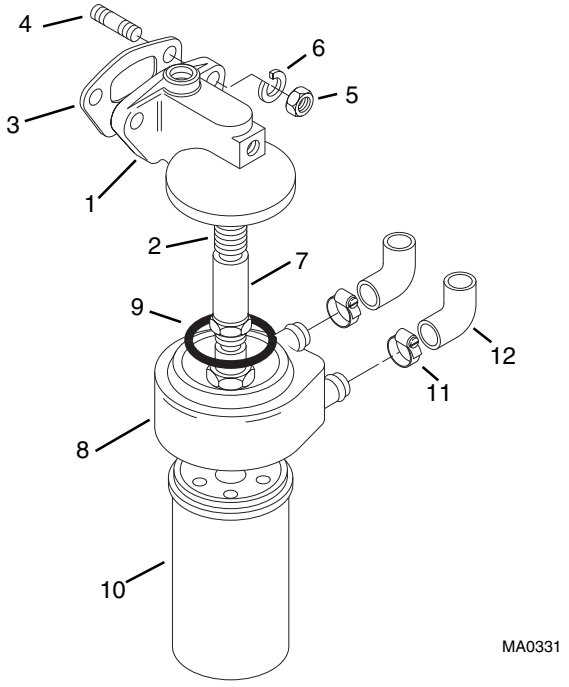
1. Where frost protection will never be required, use clean soft water with an approved corrosion inhibitor in soft water.
2. If an antifreeze mixture is used to prevent frost damage it must have an ethylene glycol (ethanediol) base. An antifreeze that conforms to one of the standards given below or to an equal standard is acceptable if the pH value is from 7.0 to 8.5 when diluted.
   - U.S.A.—ASTM D3306-74: Ethylene Glycol Base Engine Coolant
   - U.K.—BS 3151: 1959: Ethanediol Antifreeze Type B with Sodium Benzoate and Sodium Nitrite Inhibitors
   - Australia—AS 2108-1977: Antifreeze Compounds and Corrosion Inhibitors for Engine Cooling Systems

   Check the quality of the antifreeze coolant at least once a year, for example, at the start of the cold period.
3. There is an advantage to using antifreeze even when frost protection is not necessary. An approved antifreeze as described in paragraph 2 protects against corrosion and also raises the boiling point of the coolant. A 50 percent concentration of antifreeze is preferred, but if there is a less likely chance that this much frost protection is required, a mixture of not less than 33 percent concentration can be used. If antifreeze is not used, add an approved corrosion inhibitor mixture to the water. Change the water/corrosion inhibitor every six months or check according to the inhibitor manufacturer's recommendations.

NOTE: Some corrosion inhibitor mixtures contain soluble oil which can have an adverse effect on some types of water hose.

8.2.2 Piston Cooling Jets

Current turbocharged engines have piston cooling jets which direct cooled lubricating oil into the main pressure rail at the base of each cylinder liner onto the underside of each piston crown where it circulates, dispersing heat from the combustion area. The oil then drains back to the sump. The lubricating oil feed to the jet nozzle is controlled by a pressure relief valve fitted into the main body of the piston cooling jet assembly and comes into operation at a pressure of approximately 30 psi (206,7 kPa).



1.	Filter Head	5.	Nut (2)	9.	Seal
2.	Connection	6.	Washer (2)	10.	Oil Filter
3.	Gasket	7.	Connector	11.	Hose Clamp
4.	Stud (2)	8.	Oil Cooler	12.	Hose

Fig. 8.17 Oil Filter with Integral Oil Cooler

8.2.3 Integral Oil Cooler in Oil Filter

The oil filter for a turbocharged engine, Fig. 8.17, has an integral oil cooler. Whenever you change engine coolant, drain the oil cooler by removing inlet or outlet connections, flush the cooler and reconnect hose.

8.3 ENGINE ELECTRICAL SYSTEM

The engine electrical system is described in Section 10, Electrical System. These instructions describe warning devices, wiring harnesses, circuit breakers, the starting and charging circuits, switches and solenoids, gauges and indicator lights, and electrical troubleshooting.

8.4 ENGINE FUEL SYSTEM

The engine fuel system includes a fuel tank (1, Fig. 8.18), a fuel level sender (2) and gauge, a fuel pre-filter (3), a fuel pump, Fig. 8.10, a fuel filter (22, Fig. 8.18), and fuel lines to and from the fuel injection pump, and fuel lines from the fuel injection pump to and from the fuel injectiors back to the fuel filter and fuel tank. A separate line runs from the fuel filter to the Thermo Start plug, Fig. 8.14, in the intake manifold.

The threaded fuel fill opening in the top of the fuel tank has a filler cap with a tether (3, Fig. 8.18). A fuel level sender (2) and gauge are described in Section 10, Electrical System.

A fuel supply hose carries fuel from the bottom of the tank to the fuel pre-filter (21). The fuel then flows through a fuel filter tube, a hose and a fuel pump tube to the fuel lift pump, Fig. 8.10, which is located on the left side of the engine.

A tube carries fuel under pressure from the fuel lift pump to the fuel filter (22, Fig. 8.18). Fuel which has been filtered by the fuel filter is directed through tubes to the fuel injection pump and to the Thermo Start plug, Fig. 8.14 in the intake manifold.

A tube from the fuel injection pump returns surplus fuel to the fuel filter (22, Fig. 8.18) for recirculation back to the fuel injection pump.

A tube from the fuel injectors returns surplus fuel from the injectors to the fuel filter (22) and into a line and hose which returns it to the fuel tank.

8.4.1 Type of Diesel Fuel to Use

Fuel represents a major portion of your forklift operating costs; therefore, it is important to use it efficiently. Don't let cost tempt you to use inferior diesel fuel. The initial savings is a false economy when you consider the damage poor fuel can do to your forklift engine.

NOTE: Use only diesel fuel designed for diesel engines. Some heating fuels contain harmful chemicals which can seriously affect engine efficiency and performance.

When operating in temperatures above 20 °F (–6,7 °C), use diesel fuel No. 2D with a minimum cetane rating of 45. When operating in temperatures below 20 °F (–6,7 °C) use diesel fuel oil No. 1D with a minimum cetane rating of 50.

NOTE: When using diesel fuel with a sulfur content below 1.3 percent, the oil filter change interval must be reduced by 75 hours. The use of fuel with a sulfur content above 1.3 percent is not recommended.

8.4.2 Fuel Tank

The fuel tank (1, Fig. 8.18) is located directly behind the front axle.

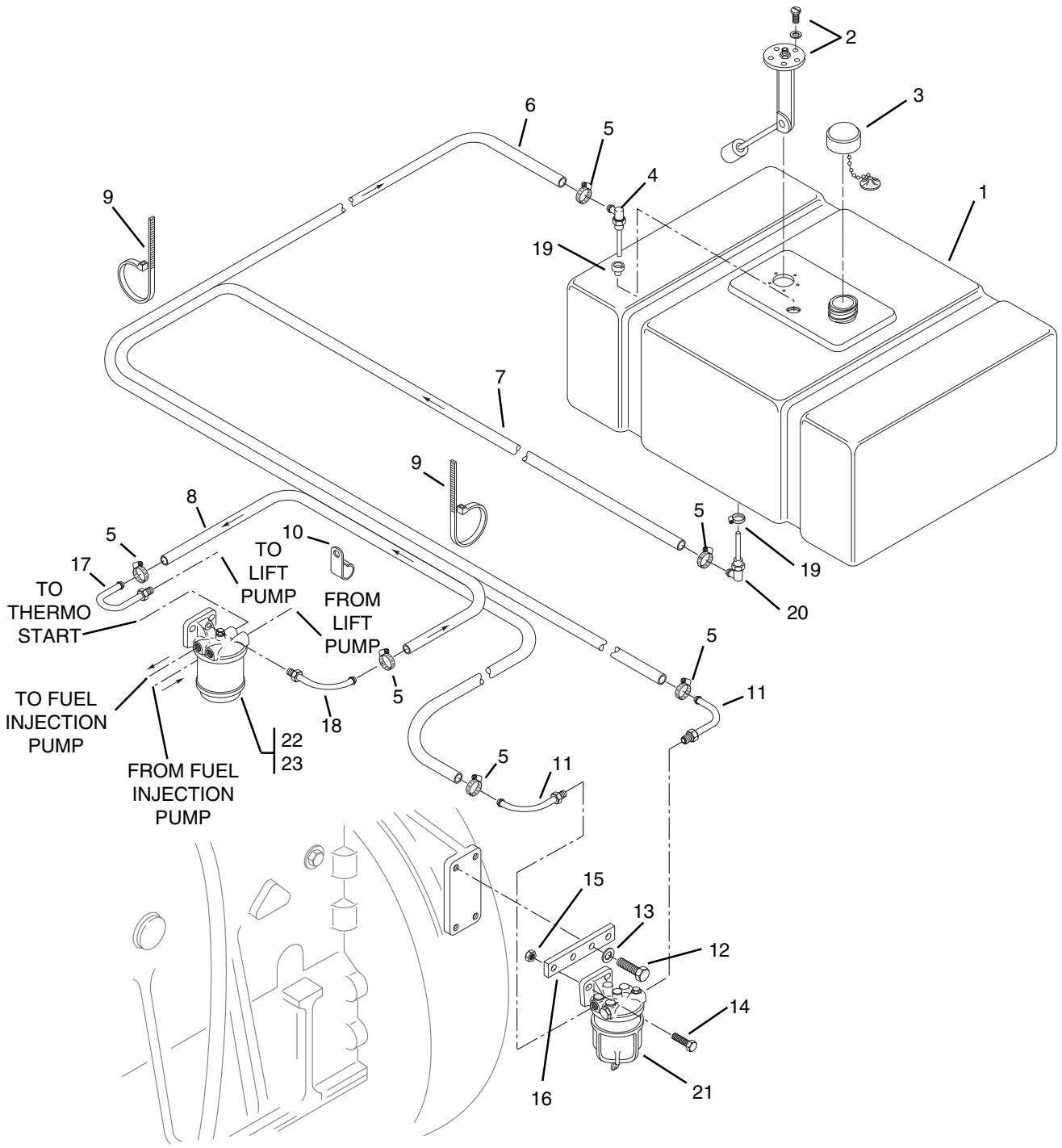
a. Removal

1. Have a dry chemical (Class B) fire extinguisher near the work area.
2. Disconnect the negative battery cable.
3. Using a hand operated pump, when available, pump as much fuel as possible through the fill cap or fuel level sensor openings in the fuel tank. Pump the fuel oil into a marked and approved receptacle for fuel oil.

Caution !

Never drain or store fuel in an open container due to the possibility of fire; discard the fuel in an approved manner.

4. Prepare to drain remaining fuel by centering a receptacle which can hold the remaining fuel beneath the elbow (20, Fig 8.18) at the bottom of the tank. Loosen hose clamp (5) at the bottom of the tank, twist fuel supply hose (7) off elbow (20), and drain fuel into receptacle. Discard the fuel in an approved manner.
5. Loosen hose clamp (5) and twist the fuel return hose (6) off elbow (4).
6. Disconnect wires 17 and 21 from fuel level sender.
7. Lift and tilt the rear of the tank to remove it from the forklift.



PA0424b

1. Fuel Tank
2. Fuel Level Sender
3. Filler Cap with Tether
4. Elbow, 90°, with standpipe
5. Hose Clamp
6. Fuel Return Hose
7. Fuel Supply Hose
8. Fuel Supply Hose
9. Tie Wrap
10. Hose Support
11. Fuel Filter Tube
12. Capscrew, hex head
13. Lock Washer
14. Capscrew, hex head
15. Lock Nut
16. Mounting Bar
17. Fuel Pump Tube
18. Fuel Filter Tube
19. Rubber Bushing
20. Elbow, 90°, with standpipe
21. Fuel Pre-Filter Assembly
22. Fuel Filter Assembly
23. Fuel Filter Element Kit for Item 22

Fig. 8.18 Engine Fuel System

b. Disassembly

1. Remove five capscrews, fuel level sender (2, Fig. 8.18) and gasket from fuel tank.
2. Remove fuel supply and return elbows (4 and 20) and rubber bushings (19) from fuel tank.

c. Cleaning and Drying

Warning !

This procedure will not remove all fuel vapor. Do not attempt any repair on tank where heat or flame is required, as an explosion resulting in personal injury could occur.

If contaminated fuel or foreign material is in the tank, the tank can usually be cleaned. Replace tank if tank is damaged or if there are leaks in unreparable areas.

Clean the tank as follows:

1. Have a dry chemical (Class B) fire extinguisher near the work area.
2. Disconnect the negative (–) battery cable.
3. Remove and disassemble fuel tank as described in paragraphs a and b. Invert, rock and drain tank.
4. Clean tank with high pressure washer or flush with hot water for five minutes. Invert, rock and drain tank completely.
5. If necessary, add a diesel fuel emulsifying agent to the tank, refill with water, and agitate mixture for 10 minutes. Drain tank completely. Refer to manufacturer's instructions for correct emulsifying agent to water mixture.
6. When empty, refill to overflowing with water. Completely flush and empty tank.

d. Inspection and Replacement

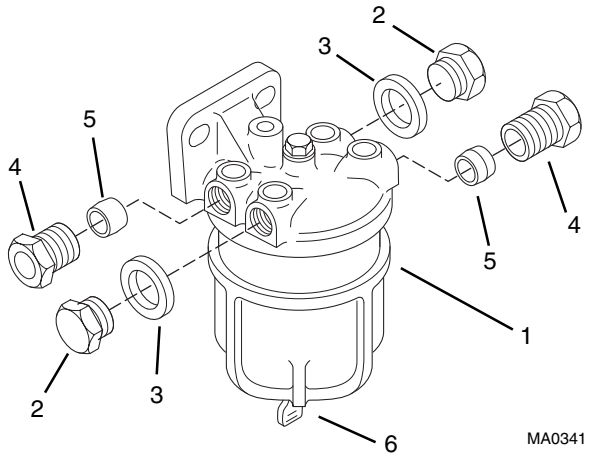
1. Plug all outlets before removing a fuel tank for a suspected fuel leak; make sure that one of the fuel hoses isn't leaking onto the tank.
2. To test a fuel tank which is out of the forklift, plug all openings except a supply or return elbow. Apply a small amount of air pressure to tank through this elbow (approximately 1 to 1-1/2 psi (0,07 to 0,10 bar). Test tank for leaks by applying soap solution to exterior of tank or by submerging tank in water and looking for bubbles.
3. For a short term repair you may be able to repair a small leak by installing a sheet metal screw with a neoprene gasket in the opening. Replace tank for long term repair.

e. Assembly

1. Install rubber bushings (19, Fig. 8.18) and fuel supply and return elbows (4 and 20) in tank.
2. Position fuel level sender gasket and fuel level sender (2) in tank.
3. Loosely install the screw which secures the ground wire to the sender and fuel tank.
4. Install the other four screws and alternately torque the five screws which secure the sender to the fuel tank from 10 to 14 lb-inch (1,13 to 1,58 N m). Use No. 10-24 screws.
5. Install the wire and nut on the center terminal of the sender.

8.4.3 Fuel Level Sender and Gauge

The fuel level sender and gauge assembly is described in Section 10, Electrical System.



1. Fuel Pre-Filter
2. Plug
3. Washer
4. Nut
5. Ferrule
6. Drain Cock

Fig. 8.19 Fuel Pre-Filter

8.4.4 Fuel Pre-Filter

Drain water from fuel pre-filter, Fig. 8.8 and 8.19, every 250 hours of operation.

1. Unlock and open the right rear engine access door.
2. Loosen drain cock (6, Fig. 8.19) on underside of fuel pre-filter and drain all water from bowl.
3. Tighten drain cock after draining.
4. Close and lock access door.

a. Removal

1. Remove fuel pre-filter inlet and outlet tubes (11, Fig. 8.18).
2. Support filter with one hand and remove lock nuts (15) and capscrews (14) and remove fuel pre-filter from mounting bar.
3. Remove locknut (15), capscrew (12), lock washer (13) and mounting bar (16).

b. Disassembly

Loosen the hex head screw in the top of the filter and separate the filter base from the filter head.

c. Cleaning and Drying

Clean the pre-filter using an approved solvent and dry with a clean, lint-free cloth.

d. Assembly

Assemble filter base to filter head using hex head screw.

e. Installation

1. Install mounting bar (16, Fig. 8.8) using capscrew (12), lock washer (13) and lock nut (15).
2. Hold filter in position and install capscrews (14) and lock nuts (15) to secure filter to mounting bar.

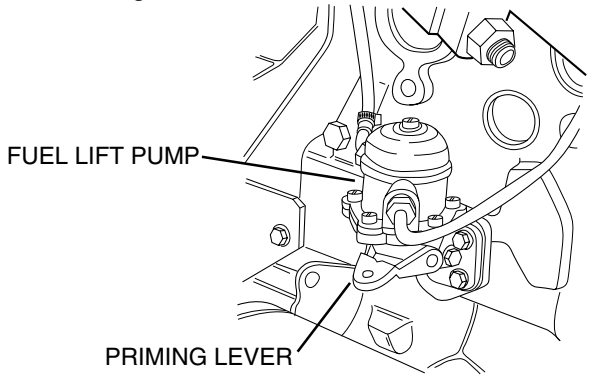


Fig. 8.20 Fuel Lift Pump

8.4.5 Fuel Lift Pump

Clean fuel lift pump sediment chamber, Fig. 8.10 and 8.20, every 500 hours of operation.

1. Unlock and open the left rear engine access door.
2. Remove fuel lift pump cover screw, cover washer, cover, and strainer.
3. Wash any sediment from lift pump and clean cover and strainer.
4. Install strainer and cover making sure that cover seats on pump with NO leakage.
5. Remove air from the fuel system. (See paragraph 8.4.8, How to Bleed to Fuel System).
6. Close and lock access door.

a. How to Test the Fuel Lift Pump in Position

1. Disconnect the outlet line from the lift pump to the fuel filter.
2. Rotate the engine. There should be a spurt of fuel from the outlet port once every two revolutions.

b. How to Test Pressure with Pump in Place

1. Fit a 0 to 10 psi (0 to 0,7 bar) pressure gauge to the outlet of the pump. Ensure that there are no leaks at the connections between pump and gauge.
2. Crank the engine for 10 seconds and note the maximum pressure on gauge. If the pressure recorded is less than 75 percent of minimum production static pressure which is 4.5 psi (0,31 kgf/cm^2 or 31 kN/m^2), then repair or replace the pump.

NOTE: Minimum production static pressure is 6 psi (0,42 kgf/cm^2 or 41 kN/m^2).

Also observe the rate at which the pressure drops to half the maximum figure obtained when cranking has ceased. If less than 30 seconds, repair or replace the pump.

NOTE: These figures apply to a 4-bolt-type fuel lift pump. If your engine has a 2-bolt-type fuel lift pump, contact your Perkins Engine Distributor for pump pressure specifications.

a. Fuel Lift Pump Removal

1. Disconnect lines from fuel pre-filter and to the fuel filter.
2. Remove four capscrews and lock washers that secure the fuel lift pump to the engine.

b. Disassembly and Assembly

Refer to your Perkins Engine Distributor for disassembly and servicing of the fuel lift pump.

c. Cleaning and Drying

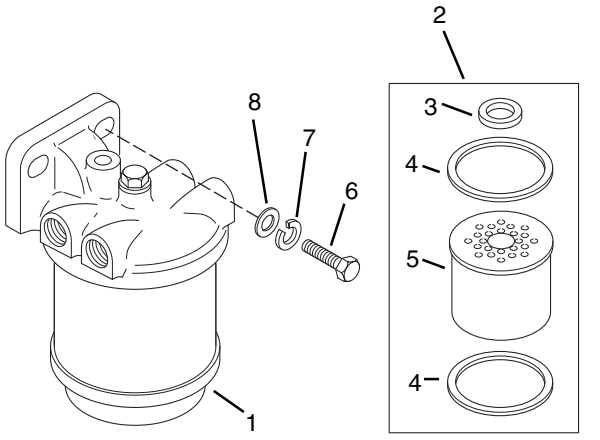
Clean the pump as described in paragraph 8.1.5, Fuel Lift Pump Sediment Chamber. Clean the exterior of the pump with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

Refer to your Perkins Engine Distributor if fuel lift pump requires component replacement or repair.

e. Fuel Lift Pump Installation

Position the fuel lift pump on the engine and install the four capscrews and lock washers that secure the fuel lift pump to the engine.



1. Fuel Filter
2. Filter Element Kit
3. Seal
4. Gasket (2)
5. Filter Element
6. Screw (2)
7. Washer (2)
8. Washer (2)

Fig. 8.21 Fuel Filter

8.4.6 Fuel Filter

Change element (5, Fig. 8.21) every 500 hours of operation.

1. Unlock and open the right rear engine access door.
2. Loosen hex screw in top of filter, Fig. 8.9, and lower filter bowl cover.
3. Remove and discard element and gaskets.
4. Before you put new filter element into lower cover, clean top and bottom filter covers and install new gaskets.
5. Position new filter element between base and head and install hex screw to secure parts.
6. Remove air from the fuel system. (See paragraph 8.4.8, How to Bleed to Fuel System).

a. Fuel Filter Removal

1. Disconnect lines from fuel pump, to fuel injection pump, from fuel injection pump, to Thermo Start, from fuel pipe and to fuel tank.
2. Support fuel filter with one hand and remove capscrews and lock washers that secure fuel filter and bracket to engine.
3. Remove filter from engine. Hold filter upright until you pour fuel oil from filter into an approved container. Dispose of the fuel in an approved manner.

b. Disassembly

Remove hex screw in top of filter, Fig. 8.9, remove filter base and discard element.

c. Cleaning and Drying

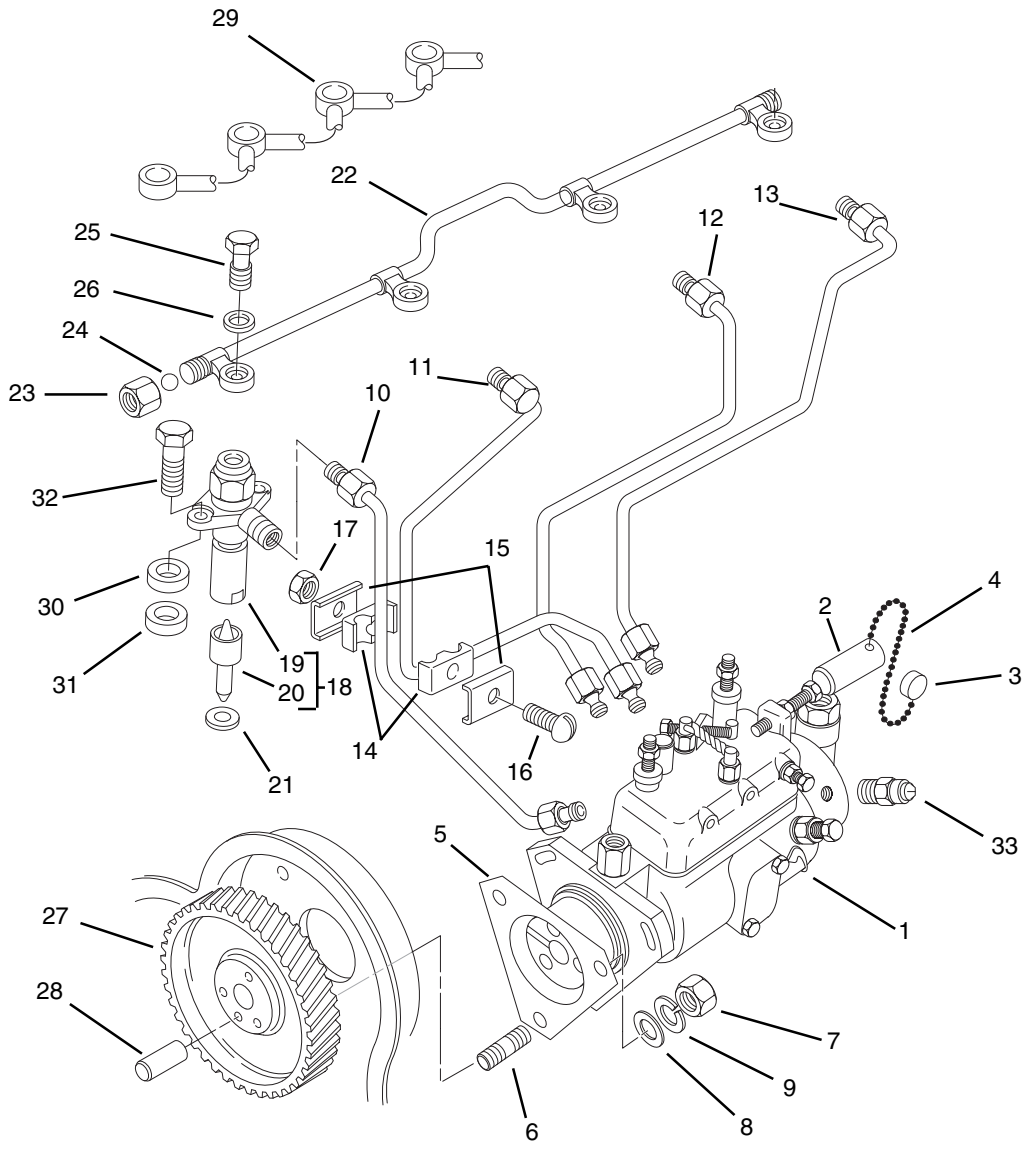
Clean the filter using an approved solvent and dry with a clean, lint-free cloth.

d. Assembly

Position new filter element between base and head and install hex screw to secure parts.

e. Installation

1. Support fuel filter with one hand and install capscrews and lock washers that secure fuel filter and bracket to engine.
2. Connect lines from fuel pump, to fuel injection pump, from fuel injection pump, to Thermo Start, from fuel pipe and to fuel tank.



1. Fuel Injection Pump
2. Sleeve
3. Seal
4. Wire
5. Gasket
6. Stud (3)
7. Nut (3)
8. Washer (3)
9. Washer (3)
10. Injection Pipe for No. 1 Cylinder
11. Injection Pipe for No. 2 Cylinder
12. Injection Pipe for No. 3 Cylinder
13. Injection Pipe for No. 4 Cylinder
14. Bridle (4)
15. Plate (4)
16. Screw (2)
17. Nut (2)
18. Atomizer (4)
19. Holder
20. Nozzle
21. Washer (4)
22. Pipe
23. Union Nut
24. Ball
25. Bolt (4)
26. Washer (8)
27. Gear
28. Dowel
29. Fuel Pipe
30. Spacer (4)
31. Seal (4)
32. Screw (8)
33. Fuel Run Solenoid

Fig. 8.22 Fuel Injection Pump

8.4.7 Fuel Injection Pump

The fuel injection pump, Fig. 8.22, is a distributor type pump with a mechanical flyweight type governor. The pump is flange mounted and is driven from the engine timing case.

IMPORTANT: *Unless the necessary equipment and experienced personnel are available, dismantling of the fuel injection pump should not be attempted.*

a. Fuel Injection Pump Removal

IMPORTANT: *Instructions and specifications in the Perkins Workshop Manual for the Perkins 4.236 Series Engine are required for fuel injection pump installation. Do not remove pump from engine unless you have this information which is essential to correct fuel injection pump installation.*

1. Remove the high and low pressure pipes from the fuel pump.
2. Disconnect the stop and throttle controls and remove return springs.
3. Disconnect wiring to the fuel run solenoid.
4. Remove the timing case front cover inspection plate.
5. Remove the three screws which secure the fuel pump gear to the fuel pump.
6. Remove the fuel pump from the timing case ensuring that when the fuel pump gear leaves the shaft it stays in mesh with the idler gear; otherwise fuel pump timing will be affected.

b. Fuel Injection Pump Disassembly

IMPORTANT: *Unless the necessary equipment and experienced personnel are available, dismantling of the fuel injection pump should not be attempted.*

Refer to your Perkins Engine Distributor for disassembly and servicing of your fuel injection pump.

c. Cleaning and Drying

Clean the exterior of the fuel injection pump with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

Refer to your Perkins Engine Distributor if fuel injection pump requires component replacement or repair.

e. Fuel Injection Pump Installation

IMPORTANT: *Instructions and specifications in the Perkins Workshop Manual for the Perkins 4.236 Series Engine are required for fuel injection pump installation. Do not remove pump from engine unless you have this information which is essential to correct fuel injection pump installation.*

f. Maximum Engine Speed Setting

IMPORTANT: *The maximum speed screw seal of the original fuel pump must not be broken or tampered with in any way unless authorized by JLG. Failure to do so may void engine and forklift warranties.*

When installing a replacement fuel injection pump (refer to paragraph 8.4.7.e) or in the event of the maximum speed screw having been moved, check and reset the maximum no load speed.

The maximum no load speed will vary according to application. For details, refer to code number stamped on fuel injection pump data plate. The last four numbers in the code indicate the speed required. In the case of the following example, this would be 3130 rev/min.

Code Example: AS62/800/0/3130

NOTE: If the fuel pump data plate is damaged or defaced so as to make it impossible to read the code, or if the code is not stamped on the plate, contact your nearest Perkins Distributor or C.A.V. dealer to obtain the correct setting.

IMPORTANT: *Under no circumstances should the engine be allowed to operate at a higher speed than specified or severe damage to the engine may result.*

8.4.8 How to Bleed the Fuel System

See paragraph 8.1.5 - 500 Hour Intervals, Bleeding Fuel System, for procedures to remove air from the fuel system.

8.4.9 Atomizers (Fuel Injectors)

Atomizers should be taken out for examination at regular intervals (refer to paragraph 8.1.7).

When replacing atomizers in the cylinder head it is essential that a new, correct type copper washer is installed between the nozzle cap and cylinder head.

Earlier engines have a one piece collar-type dust seal; later engines have an improved two-piece arrangement which consists of a soft rubber sealing ring or sleeve and a rigid plastic spacer which presses down onto the rubber sealing ring. The rubber sealing ring is always installed below the

rigid spacer.

Tighten securing nuts evenly to 12 lb-ft (16 N m).

a. How to Locate Faulty Atomizer(s)

A faulty atomizer can cause:

- Misfiring
- Knocking in one (or more) cylinders
- Engine overheating
- Loss of power
- Smoky exhaust (black)
- Increased fuel consumption

The particular faulty atomizer or atomizers may be determined by releasing the pipe union nut on each atomizer in turn, with the engine running at a fast "tick-over". If after slackening a pipe union nut the engine revolutions remain constant, this denotes a faulty atomizer.

To test the atomizer:

1. Withdraw this complete unit from the cylinder head.
2. Invert the atomizer with the nozzle facing outwards and then retighten the unions.
3. Slacken the unions of the other atomizer pipes (to avoid the possibility of engine starting).
4. Use the starter to turn the engine over until fuel sprays from the nozzle. Examine the shape of the spray. If the spray is unduly "wet" or "streaky" or obviously to one side, or if the nozzle "dribbles" it may only be necessary to probe the nozzle holes to remove carbon.

Caution !

Be careful to keep hands and face from coming in contact with spray as it will cause fuel oil to penetrate the skin.

IMPORTANT: *Do not attempt to adjust injection pressure without a testing pump and pressure gauge. It is impossible to adjust the setting of atomizers with any degree of accuracy without the proper equipment.*

A perfect atomizer, when tested by pumping fuel through it in the open air gives a short "pinging" sound as the fuel emerges from the holes. After the atomizer has been in service for some time, the "pinging" changes to a crackling sound. It is not until the atomizer sounds "dead" that its condition is likely to affect the running of the engine.

b. Atomizer Identification

Currently, the atomizer code is stamped on the atomizer body.

c. How to Replace an Atomizer

1. Remove the fuel leak off pipe.
2. Remove the high pressure pipe union nuts from the atomizer and fuel injection pump and release the pipe.
3. Remove the atomizer flange nuts and remove the atomizer and seat washer.
4. Put new atomizer with new seat washer, in position. Be sure atomizer is not tilted and tighten the flange nuts evenly by small amounts to 12 lb-ft (16 N m).
5. Connect high pressure fuel pipe and tighten nut to 15 lb-ft (20 N m).
6. Connect the leak off pipe.
7. Run the engine and check for fuel and air leakage.
8. Bleed the fuel system by following the procedures in 8.1.5, Bleeding Fuel System.

8.5 ENGINE EXHAUST SYSTEM

Warning !

- Exhaust fumes contain carbon monoxide, a colorless, odorless gas which is fatal when inhaled in a confined area. Avoid breathing exhaust fumes and be sure engine operation will not cause a concentration of toxic emissions.
- Exhaust system components get very hot and can cause serious burns.

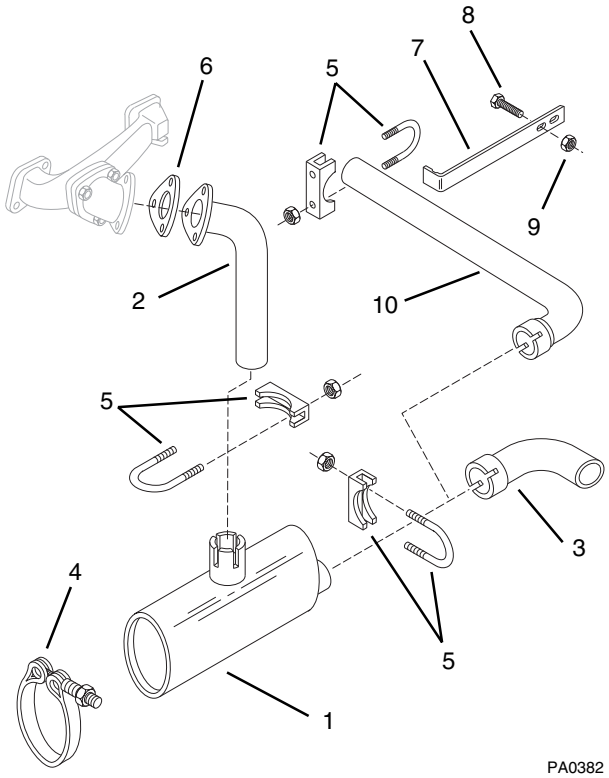
The exhaust system is supported by the engine to minimize the transfer of noise and vibration into the operators cab. The tail pipe on current forklifts is directed to the right side of the forklift which is more remote from the operators cab.

Annoying rattles and noise vibrations in the exhaust system are usually caused by misalignment of parts. When aligning the system, leave all bolts or nuts loose until all parts are properly aligned, then tighten working from front to rear.

Whenever you replace a muffler you should also replace the tail pipe.

Use Exhaust System Sealer at all slip joint connections before assembly.

When installing exhaust parts, make sure there is sufficient clearance between the hot exhaust parts and pipes and hoses and wiring that would be adversely affected by excessive heat.



1. Muffler
2. Pipe, exhaust
3. Pipe, tail
4. Clamp, T-Bolt
5. Clamp, muffler
6. Gasket, exhaust manifold
7. Flat
8. Capscrew, hex head
9. Nut
10. Pipe, tail

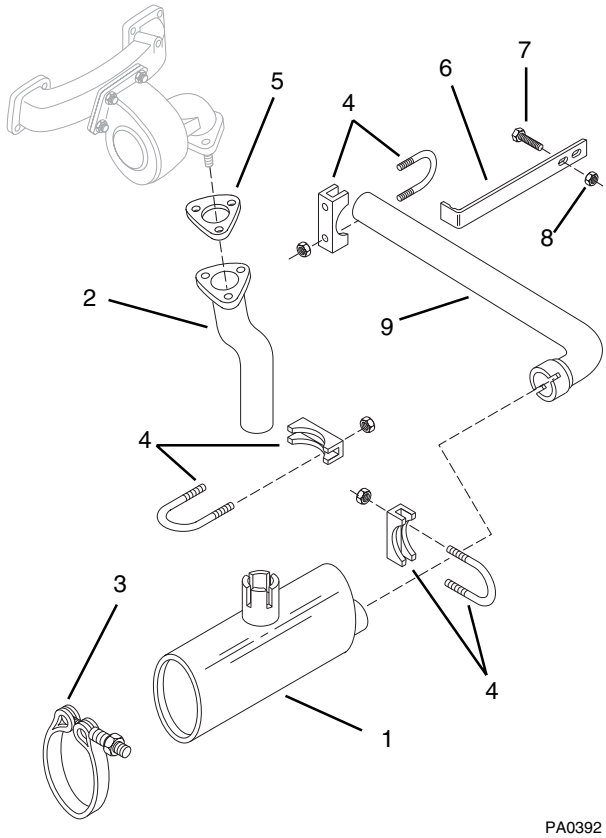
NOTE: Items 7 through 10 are for forklifts with right side exhaust, SN 8H0289 and after.

Fig. 8.23 Exhaust System for a Naturally Aspirated Engine

When installing an exhaust system be careful to provide for expansion when the system is hot.

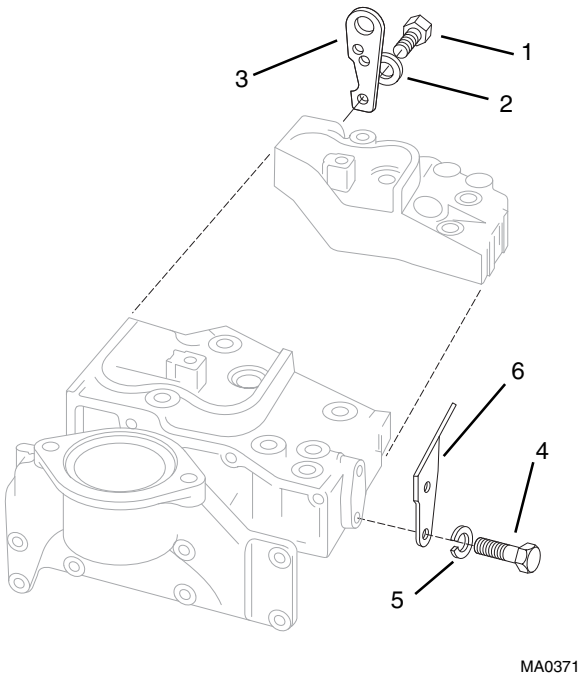
Check complete exhaust system for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections, and other deterioration which could permit exhaust fumes to seep into the operators cab. Any damaged areas must be corrected immediately.

Periodic maintenance of the exhaust system is not required; however, it is advisable to check the condition of the system when performing other maintenance on the forklift.



1. Muffler
2. Pipe, exhaust
3. Clamp, T-Bolt
4. Clamp, muffler
5. Gasket, exhaust manifold
6. Flat
7. Capscrew, hex head
8. Nut
9. Pipe, tail

Fig. 8.24 Exhaust System for Turbocharged Engine



1.	Screw (2)	3.	Plate	5.	Washer (2)
2.	Washer (2)	4.	Screw (2)	6.	Plate

NOTE: Normally the engine and transmission are removed as a unit by suspending both units from these plates. The combined weight is 1,400 lb (635 kg).

Fig. 8.25 Engine Lifting Plates

8.6 ENGINE REMOVAL

Warning

To avoid severe burns, **DO NOT** attempt this procedure when the engine, cooling, and hydraulic systems are hot. Wait until they have cooled before proceeding.

1. Remove the transmission cover and open both engine access doors.
2. Lower the boom to the ground.
3. Remove the counterweight from the rear of the frame.
4. Remove the radiator cover.
5. Remove oil cooler from the rear support and detach the lines. Catch any excess oil that drains from cooler and lines. Cap the lines.
6. Detach and remove the air cleaner system from the rear support and engine as follows:

Removal from Naturally Aspirated Engine

(a) Loosen clamp that secures the elbow to the engine inlet manifold.

(b) Loosen clamp that secures the elbow to the air cleaner assembly.

(c) Remove the nuts, lock washers, washers and capscrews that secure the air cleaner mounting band to the forklift frame.

Removal from Turbocharged Engine

(a) Loosen clamp that secures hose to hose reducer at the air inlet to the turbocharger.

(b) Loosen clamp that secures hose to hump hose at the air cleaner assembly.

(c) Remove the nuts, lock washers, washers and capscrews that secure the air cleaner mounting band to the forklift frame.

7. Detach the exhaust system from the engine at exhaust manifold as follows:

(a) Remove the parts attaching tail pipe to engine and muffler, Fig. 8.23 and 8.24.

(b) Loosen and remove the T-Bolt that secures the muffler to the engine.

(c) Remove the parts attaching the exhaust pipe to the exhaust manifold or turbocharger, as applicable.

8. Drain the radiator as follows:

(a) Remove the radiator cap.

(b) Place a container under the radiator petcock at the bottom left corner of the radiator.

(c) Open the petcock and allow the coolant to drain from the radiator.

9. Disconnect radiator overflow bottle and radiator hose connections at engine.
10. Remove the radiator, hoses, and shroud.
11. Disconnect the wiring to the backup alarm, Fig. 8.26.
12. Remove the rear support (which is above the engine between the side frame members) along with the backup alarm.

13. Disconnect the engine wire harness at the following components, Fig. 8.26:
    - Starter
    - Starter Ground Cable
    - Starter Relay
    - Neutral Start Switch (on transmission)
    - Transmission Temperature Switch
    - Low Oil Pressure Sender
    - Emergency Pump Oil Pressure Switch
    - Water Temperature Sender
    - Fuel Run Solenoid
    - Alternator
    - Thermo Start Plug

    Pull harness off of engine and forward on forklift so it is out of the way.

14. Detach and plug fuel lines as required at fuel pre-filter and fuel filter.

15. Detach throttle cable from engine as follows:
    (a) Remove cable clamp securing throttle cable to throttle cable bracket.
    (b) Disconnect the throttle cable from the fuel injection pump.

16. Remove the transmission control cables from the connector kit on the transmission as follows:
    (a) Remove the cable clamps securing the control cable to the connector kit, Fig. 4.4.
    (b) Disconnect the control cables from the swivel linkage.

17. Disconnect transmission drive shaft from the transmission:
    (a) Remove transmission cover from forklift.

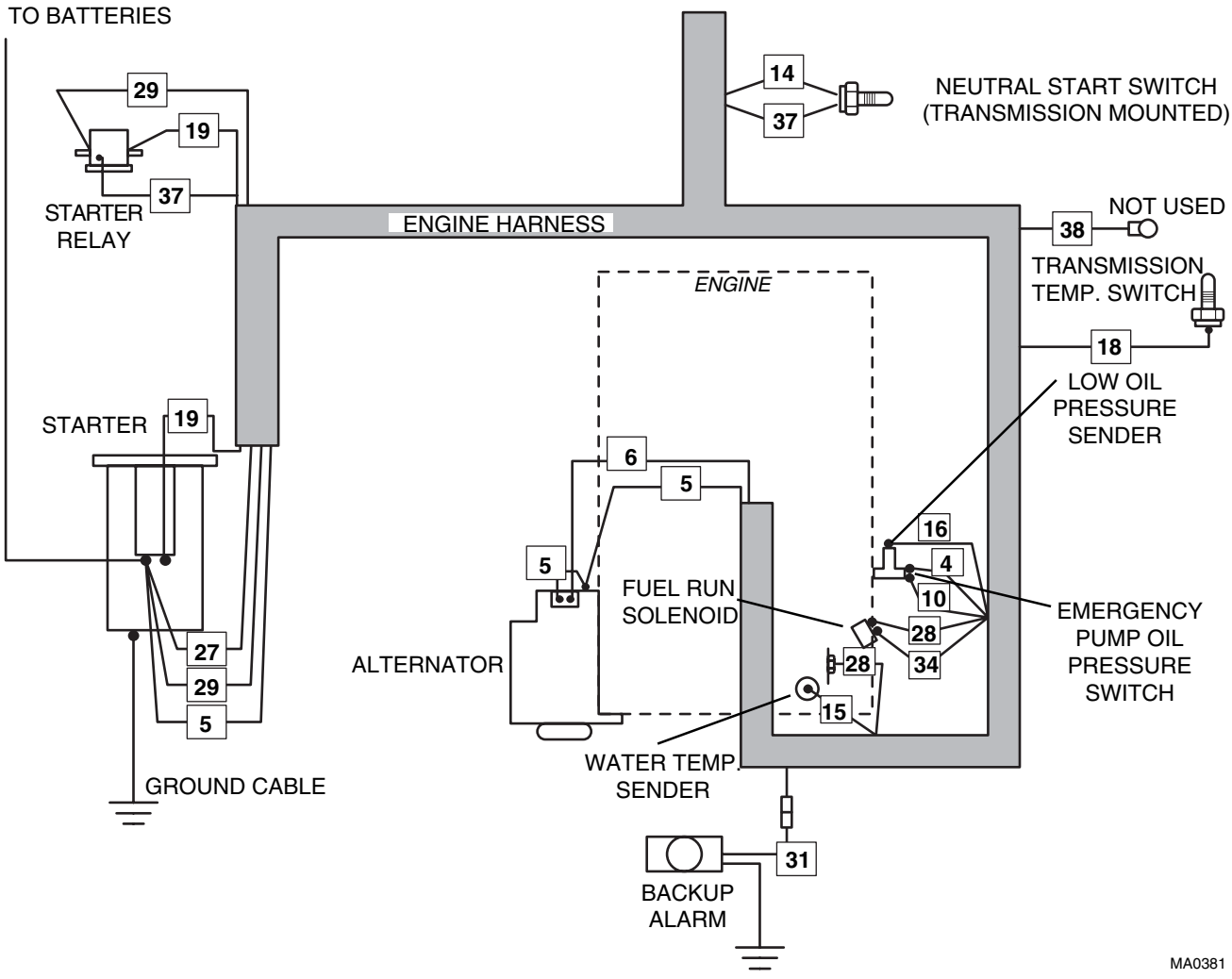


Fig. 8.26 Engine Harness Connections

(b) Remove the U-bolt assembly or bearing straps, Fig. 6.1, attaching the drive shaft cross assembly to the drop box input shaft yoke. Slide slip joint towards transmission so cross slips out of drop box input shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings don't drop off cross.

(c) Remove the cap and bolt assembly or bearing straps securing the drive shaft cross assembly to the transmission output shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings don't drop off cross.

(d) Remove drive shaft assembly from forklift.

18. Detach and remove the hydraulic lines from the main pump.

IMPORTANT: *Be sure main suction line is raised above level in reservoir.*

19. Detach and remove the transmission cooler lines at the transmission.

20. Remove the engine and transmission from the forklift frame as follows:

(a) Attach a suitable engine hoist to the lift plates, Fig. 8.25, on the top of the engine.

(b) Remove both transmission mounts from the transmission and frame.

(c) Remove the capscrew, vibration mount, rebound washer, and locknut attaching the engine mount to the frame.

(d) Pull the engine and transmission out the rear of the forklift.

21. With the engine and transmission adequately supported, separate the engine from the transmission as follows:

(a) Remove one of the two access hole plastic plugs on the engine flywheel housing.

(b) Remove the eight torque converter drive plate screws and washers.

(c) Remove the eleven capscrews securing the converter housing to the flywheel housing.

(d) Using a suitable engine hoist, separate the transmission from the engine.

8.7 ENGINE OVERHAUL

Refer to the Perkins Engine Workshop Manual for the 4.236 Series engines.

8.8 ENGINE INSTALLATION

1. Install two 2.5" (64 mm) guide studs in the engine housing as shown in Fig. 8.27.

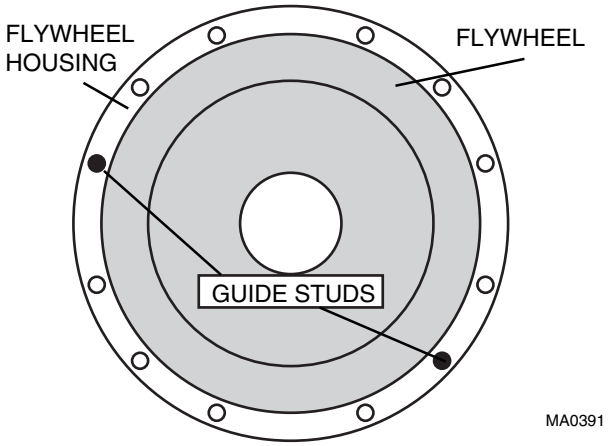


Fig. 8.27 Guide Studs

2. Rotate the engine flywheel to align a drive plate mounting screw hole with the flywheel housing access hole.

3. Install a 4.0" (100 mm) long locating stud (0.375-24 fine thread) in a drive plate nut as shown in Fig. 8.28.

4. Rotate the drive plate to align the locating stud with the flywheel drive plate mounting screw hole positioned in step 2.

5. Position the transmission on the flywheel housing with the guide and locating studs aligned.

6. Install the nine capscrews securing the converter housing to the flywheel housing.

7. Remove the two guide studs and install the remaining two capscrews securing the converter housing to the flywheel housing. Torque all eleven housing capscrews to 25 to 30 lb-ft (34 to 41 N m).

8. Using the access hole on the flywheel housing, remove the drive plate locating stud and install a capscrew in its place. Snug the capscrew, but do not tighten it.

9. Rotate the engine flywheel and individually install the remaining seven flywheel-to-drive-plate capscrews through the access hole. Snug the screws, but do not tighten them.

10. After all eight capscrews have been installed, rotate the engine flywheel again and individually torque all eight to 25 to 30 lb-ft (34 to 40,8 N m).
11. Install the engine and transmission on the forklift frame as follows:
    (a) Attach a suitable engine hoist to the lifting lugs on the top of the engine.
    (b) Push the engine and transmission in through the rear of the forklift and rest it on the frame aligning the engine mount hole.
    (c) Secure both transmission mounts to the transmission and frame with capscrews and locknuts.

- Torque the 1/2-inch capscrew attaching the mount to the frame to 68 to 72 lb-ft (93 to 98 N m).
- Torque the 3/4-inch capscrews attaching the mount to the transmission to 225 to 275 lb-ft (306 to 374 N m).

    (d) Secure the engine mount to the frame with a capscrew, vibration mount, rebound washer, and locknut. Torque to 225 to 275 lb-ft (306 to 374 N m).
    (e) Remove the engine hoist.
12. Attach the main pump to the transmission.
13. Secure transmission drive shaft to transmission with U-bolt or bearing strap. Torque U-bolt to 20 to 24 lb-ft (27 to 37 N m) or bearing strap to 55 to 60 lb-ft (75 to 82 N m).
14. Install the transmission control cables as follows:
    (a) Place the transmission control valve spools, Fig. 4.4, in the center position.
    (b) Secure the control cables to the bracket being sure to have the clamp and cable grooves aligned.
    (c) Position swivel and lock nut on rod end as shown in Fig. 4.4. Tighten the locknut.
    (d) Be sure the shifter levers are in the center or middle position.
    (e) Reposition the swivel and lock nut so it aligns with its hole in the swivel linkage control arm.
    (f) Secure the swivel to the control arm with cotter pin.

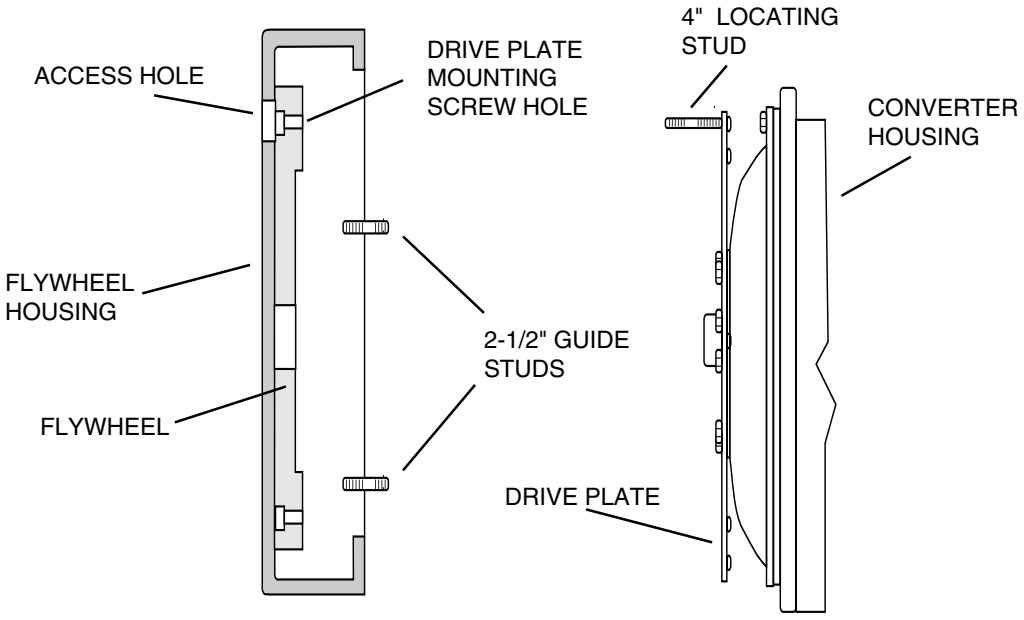


Fig. 8.28 Locating Stud

15. Attach the throttle control cable to the engine fuel injection pump as follows:
    (a) Fasten the throttle cable to the throttle cable bracket with a clamp being sure to align the grooves in the cable and clamp.
    (b) Secure the throttle cable clevis to the fuel injection pump throttle and stop lever with cotter and clevis pins. Adjust the clevis so that the lever touches the stop screw.
16. Connect the fuel lines to the fuel pre-filter and fuel filter assemblies.
17. Connect engine wire harness to the engine and transmission components, Fig. 8.26:
    - Starter
    - Starter Ground Cable
    - Starter Relay
    - Neutral Start Switch (on transmission)
    - Transmission Temperature Switch
    - Low Oil Pressure Sender
    - Emergency Pump Oil Pressure Switch
    - Water Temperature Sender
    - Fuel Run Solenoid
    - Alternator
    - Thermo Start Plug
18. Secure the rear support between the side frame members with ten capscrews, lock washers, and hex nuts. Torque to 225 to 275 lb-ft (306 to 374 N m).
19. Connect the wiring to the backup alarm.
20. Attach the exhaust system to the engine.
21. Install the air cleaner system on the rear support and connect the hoses.
22. Install the radiator overflow bottle.
23. Install the radiator, hoses, and shroud.
24. Connect the radiator hoses to the engine.
25. Fill the radiator as follows:
    (a) Be sure the radiator petcock is closed and the engine cylinder block drain plug is installed.
    (b) Fill the radiator completely with 50/50 mixture of ethylene glycol and water. Capacity is 5.4 gallons (20,4 liter).
    (c) Replace radiator cap.
    (d) Add coolant to the overflow bottle until it is about 1/4 to 1/2 full—approximately 1 quart (0,9 liter).
    (e) Clean dirt and debris from radiator fins and core. Remove rear radiator cover for access to radiator.
26. Install the transmission oil cooler on the rear support and connect it to the transmission.
27. Fill the transmission as follows:
    (a) Install a cleaned drain plug and screen and gasket, Fig. 7.1, into the transmission sump housing.
    (b) Fill transmission with Tractor Hydraulic Fluid to LOW mark on dipstick, Fig. 7.6.
28. Install the radiator cover.
29. Install counterweight on the rear of the frame.
30. Check the fluid levels as follows:
    (a) Start the engine and allow it to heat to operating temperature. Do not operate engine for more than two minutes.
    (b) **Shut the engine off,** wait for engine to cool, and check the coolant level. Top it off as required by adding coolant through the overflow bottle.
    (c) Be sure the engine oil level is between the full and add marks. If it is below the add mark, add 10W30 motor oil equal to API, SE CC or SE CD specifications. Engine crankcase capacity is 9.4 quarts (8,9 liter) with a filter change.
    (d) Check the transmission oil level. If it is below the add mark, add Tractor Hydraulic Fluid to bring it to the full mark on the dipstick. Transmission capacity is 4.3 gallons (16,3 liter).
31. Install the transmission cover and close and lock both engine access doors.

8.9 HEAD TORQUE CHECK

1. Run engine until coolant outlet temperature is higher than 170 °F (77 °C).
2. Stop the engine and remove the cylinder head cover.
3. Check the torque of the cylinder head nuts and capscrews in the correct sequence as shown in Fig. 8.29. The correct torque is 100 lb-ft (136 N m) for 1/2" studs and capscrews; 60 lb-ft (84 N m) for 7/16" studs.
   - If a nut or a capscrew turns when checked, tighten it to the correct torque.
   - If a nut or a capscrew does not turn when checked, loosen it by 30 to 60° and then tighten to correct torque.

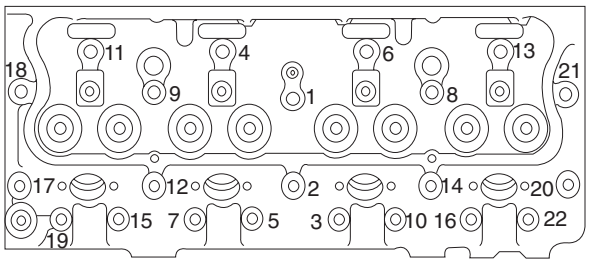


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Fig. 8.29 Cylinder Head Torque Sequence

4. After all the nuts and capscrews have been checked, check the first 10 positions again to ensure that they are still to the correct torque. During this last check, do not loosen the nuts and capscrews.

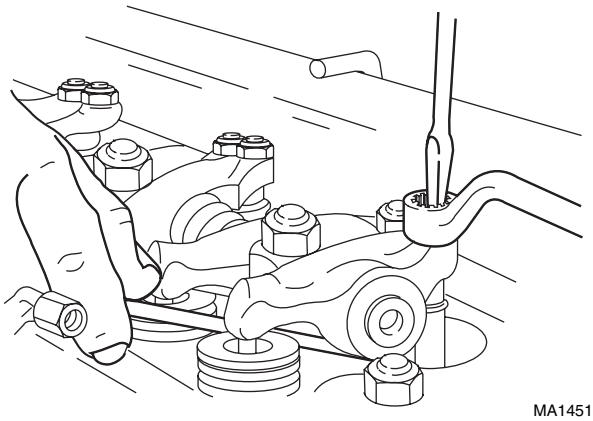

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Fig. 8.30 Valve Stem Tip Clearance Check

8.10 STEM TIP TO ROCKER ARM CLEARANCE CHECK

The correct clearance between the top of the valve stem and the rocker lever is 0.012" (0,30 mm) with the engine cold.

NOTE: No. 1 cylinder is at the front of the engine.

To adjust this clearance:

1. Turn the crankshaft in the normal direction of rotation until the inlet valve of No. 4 cylinder has just opened and the exhaust valve of the same cylinder has not fully closed. Check the clearances of No. 1 cylinder valves and adjust if necessary, Fig. 8.30.
2. With No. 2 cylinder valves set as given above for No. 4 cylinder, check and adjust clearances for No. 3 cylinder valves.
3. With No. 1 cylinder valves set, check and adjust clearances of No. 4 cylinder valves.
4. With No. 3 cylinder set, check and adjust

clearances of No. 2 cylinder valves.

8.11 ENGINE STORAGE

Use the following procedures immediately when engine is removed from service for an extended period. The instructions for the use of Perkins POWERPART products are given on the outside of each container.

1. Clean outside of engine.
2. Where a preservative fuel is to be used, drain the fuel system and fill with the preservative fuel. POWERPART Lay-Up 1 can be added to the normal fuel to change it to a preservative fuel. If preservative fuel is not used, the system can be kept charged with normal fuel but this will have to be drained and discarded at the end of the storage periods together with the fuel filter.
3. Run the engine until it is warm. Correct any fuel, lubricating oil or air leakage. Stop the engine and drain the lubricating oil sump.
4. Replace the lubricating oil filter canister.
5. Fill the sump to the FULL mark on the dip stick with clean new lubricating oil or with an approved preservative fluid. POWERPART Lay-Up 2 can be added to the lubricating oil to protect against corrosion. If a preservative fluid is used, this must be drained and normal lubricating oil used when the engine is returned to service.
6. Drain the cooling system as described in paragraph 8.1.8. To give protection against corrosion, it is better to fill the cooling system with a coolant that has a corrosion inhibitor (see paragraph 8.2.1). If frost protection is needed, use an antifreeze mixture. If no frost protection is needed, use water with an approved corrosion inhibitor mixture.
7. Run the engine for a short period to send the lubricating oil and coolant around the engine.
8. Clean out the engine breather pipe (where fitted) and seal the end of the pipe.
9. Remove the atomizers and spray POWERPART Lay-Up 2 into each cylinder bore. If this is not available, clean engine lubricating oil will give a degree of protection. Spray into cylinder bores 1/4 pint (140 ml) of lubricating oil divided evenly between the four cylinders.
11. Remove the air filter and any pipe installed between the air filter and induction manifold. Spray POWERPART Lay-Up 2 into the induction manifold. Seal the manifold with waterproof tape.
12. Remove the exhaust pipe. Spray POWERPART Lay-Up 2 into the exhaust manifold. Seal the manifold with waterproof tape.
13. Remove the lubricating oil filler cap. Spray POWERPART Lay-Up 2 around the rocker shaft assembly. Replace the filler cap.
14. Disconnect the batteries and put them into safe storage in a fully charged condition. Before the batteries are put into storage, give the battery terminals a protection against corrosion. POWERPART Lay-Up 3 can be used on the terminals.
15. Seal the vent pipe of the fuel tank or the fuel filler cap with waterproof tape.
16. Remove the fan belt and put it into storage.
17. To prevent corrosion, spray the engine with POWERPART Lay-Up 3. Do not spray the inside of the alternator cooling fan area.

NOTE: Before the engine is started after a period in storage, operate the starter motor with one of the fuel run solenoids wires disconnected until oil pressure shows on the oil pressure gauge or the warning light goes out.

If the engine protection is done correctly according to the above recommendations, no corrosion damage will normally occur. Perkins Engines Ltd. and JLG are not responsible for any damage that occurs in relation to a service storage period.

8.12 TROUBLESHOOTING

Trouble	Possible Causes (see Key)
Low Cranking Power	1, 2, 3, 4
Will Not Start	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 31, 32, 33
Difficult Starting	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 24, 29, 31, 32, 33
Lack of Power	8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33, 61, 63
Misfiring	8, 9, 10, 12, 13, 14, 16, 18, 19, 20, 25, 26, 28, 29, 30, 32
Excessive Fuel Consumption	11, 13, 14, 16, 18, 19, 20, 22, 23, 24, 25, 27, 28, 29, 31, 32, 33, 63
Black Exhaust	11, 13, 14, 16, 18, 19, 20, 22, 24, 25, 27, 28, 29, 31, 32, 33, 61, 63
Blue/White Exhaust	4, 16, 18, 19, 20, 25, 27, 31, 33, 34, 35, 45, 56, 62
Low Oil Pressure	4, 36, 37, 38, 39, 40, 42, 43, 44, 58
Knocking	9, 14, 16, 18, 19, 22, 26, 28, 29, 31, 33, 35, 36, 45, 46, 59
Erratic Running	7, 8, 9, 10, 11, 12, 13, 14, 16, 20, 21, 23, 26, 28, 29, 30, 33, 35, 45, 59
Vibration	13, 14, 20, 23, 25, 26, 29, 30, 33, 45, 47, 48, 49
High Oil Pressure	4, 38, 41
Overheating	11, 13, 14, 16, 18, 19, 24, 25, 45, 50, 51, 52, 53, 54, 57
Excessive Crankcase Pressure	25, 31, 33, 34, 45, 55, 60
Poor Compression	11, 19, 25, 28, 29, 31, 32, 33, 34, 46, 59
Starts and Stops	10, 11, 12

Key to Possible Causes

1. Battery capacity low
2. Bad electrical connection
3. Faulty starter motor
4. Incorrect grade of lubricating oil
5. Low cranking speed
6. Fuel tank empty
7. Faulty stop control operation
8. Blocked fuel feed line
9. Faulty fuel lift pump
10 Choked fuel filter
11. Restriction in air cleaner
12. Air in fuel system
13. Faulty fuel injection pump
14. Faulty atomizers or incorrect type
15. Incorrect use of cold start equipment
16. Faulty cold start equipment
17. Broken fuel injection pump drive
18. Incorrect fuel pump timing
19. Incorrect valve timing
20. Poor compression
21. Blocked fuel tank vent
22. Incorrect grade of fuel
23. Sticking throttle or restricted movement
24. Exhaust pipe restriction
25. Leaking cylinder head gasket
26. Overheating
27. Cold running
28. Incorrect tappet adjustment
29. Sticking valves
30. Incorrect high pressure pipes
31. Worn cylinder bores
32. Pitted valves and seats
33. Broken, worn or sticking piston ring(s)
34. Worn valve stems and guides
35. Overfull air cleaner
36. Worn or damaged bearings
37. Insufficient oil in sump
38. Inaccurate gauge
39. Oil pump worn
40. Pressure relief valve sticking open
41. Pressure relief valve sticking closed
42. Broken relief valve spring
43. Faulty suction pipe
44. Choked oil filter
45. Piston seizure
46. Incorrect piston height
47. Damaged fan
48. Faulty engine mounting
49 Incorrectly aligned flywheel housing, or flywheel
50. Faulty thermostat
51. Restriction in water jacket
52. Loose fan belt
53. Choked radiator
54. Faulty water pump
55. Choked breather pipe
56. Damaged valve stem oil deflectors (if fitted)
57 Coolant level too low
58. Blocked sump strainer
59. Broken valve spring
60. Exhauster or vacuum pipe leak
61. Turbo impeller damaged or dirty
62. Turbo lubricating oil seal leak
63. Induction system leaks (turbocharged engines)

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SECTION 9
HYDRAULIC SYSTEM

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Warning !

- If anyone is injured by or if any hydraulic fluid is injected into the skin, obtain medical attention immediately or gangrene may result.
- Wear appropriate eye protection. Hydraulic fluid can cause permanent eye injury. Do not wear loose fitting clothing when servicing the forklift.

9.1 CIRCUITS

NOTE: *Refer to the 6036 Hydraulic Schematic in the Troubleshooting Section 9.5 for an overall diagram*

9.1.1 Boom Raise/Lower

a. Description

Hydraulic pressure is applied in the boom raise/lower circuit by the 30 gpm section (rear half) of the **tandem pump,** which draws its fluid through a suction strainer in the reservoir, Fig. 9.1. Supply pressure is directed to either side of the right and left boom hoist cylinder pistons, by the shifting of a spool in a directional control valve found in the main control valve assembly. The spool is shifted by the **operator joystick** and its associated control cable. The joystick positions for raising and lowering the boom are as follows:

Center Position

When the joystick is placed in the center or neutral position, the directional control valve spool is positioned so that supply pressure is directed through ports F to C, Fig. 9.1, to the return filter and reservoir, Fig. 9.1. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

Raise Position

When the joystick is placed in the raise position, the directional control valve spool is shifted so that supply pressure is directed through ports E to A, Fig. 9.1, to the base end of both left and right boom hoist cylinder pistons. If supply pressure reaches 2650 psi (182,6 bar), the **boom hoist**

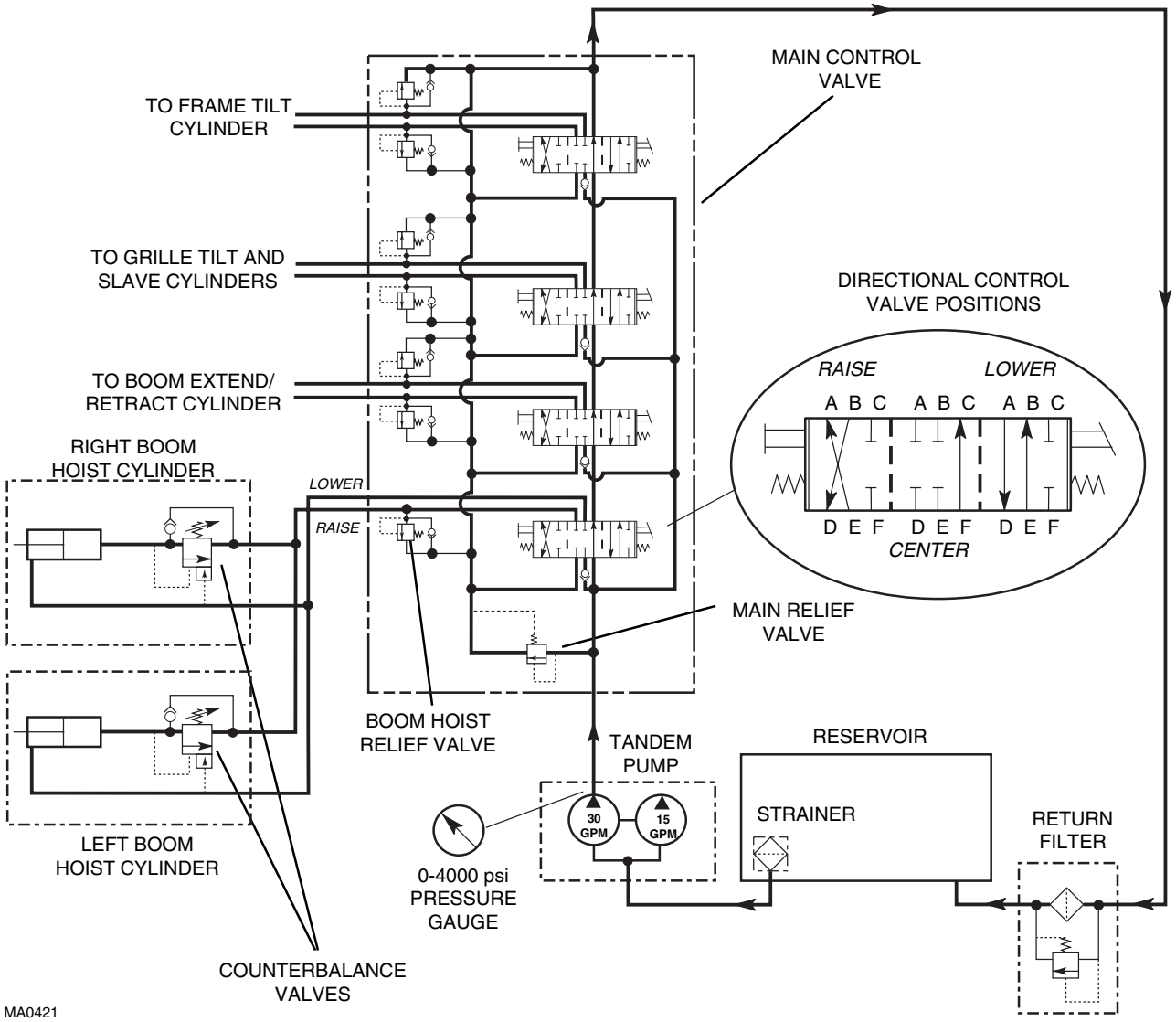


Fig. 9.1 Boom Hoist Circuit

port relief valve, Fig. 9.2, will open allowing hydraulic oil to return to the reservoir.

Return oil from the top end of the boom hoist cylinder piston is directed back to the directional control valve through ports B to D, Fig. 9.1, to the return filter and reservoir. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

Lower Position

When the joystick is placed in the lower position, the directional control valve spool is shifted so that supply pressure is directed through ports E to B, Fig. 9.1, to the rod (top) end of both left and right boom hoist cylinder pistons. This supply pressure also pilots open the **counterbalance valve**, Fig. 9.1. The open counterbalance valve allows return oil from the base end of the cylinder to return through ports A to D, Fig. 9.1, of the directional control valve to the **return filter** and **reservoir**. If supply pressure reaches 3,000 ± 50 psi (206,7 ± 3,4 bar), the **main relief valve,** Fig. 9.2, will open, allowing hydraulic oil to return to the reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

The counterbalance valve in each boom hoist cylinder serves as a safety device. The counterbalance valve functions as follows:

> Should any of the hydraulic lines going to either hoist cylinder fail, there will be a loss of hydraulic system pressure to the cylinder(s). *Example:* If there was a hydraulic line failure in the pressurized lowering line during lower-

ing, the counterbalance valve would lose pilot pressure closing off flow returning to the reservoir. The oil in the base end of the cylinder would then be trapped, which would immediately stop boom lowering and prevent an elevated load from falling to the ground uncontrolled. The load can be lowered safely to the ground by following the "Emergency Boom Lowering" procedures in your Owners/ Operators Manual.

IMPORTANT: *DO NOT attempt to reset the counterbalance valve cartridges. In the event that the counterbalance valve cartridges were disabled for emergency boom lowering or any unauthorized adjustments are ever made to these cartridges, remove and replace both cartridges with new parts. Failure to replace these cartridges with new parts may alter the holding characteristics of the counterbalance valves creating an unsafe condition for machine operation.*

b. Pressure Checks and Adjustments

Main Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0 - 4000 psi (275,6 bar) in the tandem pump outlet of the 30 gpm section, Fig. 9.1.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Raise and lower the boom fully several times to purge the system of air.
6. Depress the accelerator to full throttle. Place the joystick in the "lower" position and hold until the hoist cylinders have fully retracted. Continue holding the joystick in the "lower" position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 3,000 ± 50 psi (206,7 ± 3,4 bar). If not, adjust the main relief valve, Fig. 9.2, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13,5 ± 2 N m) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Raise and lower the boom fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

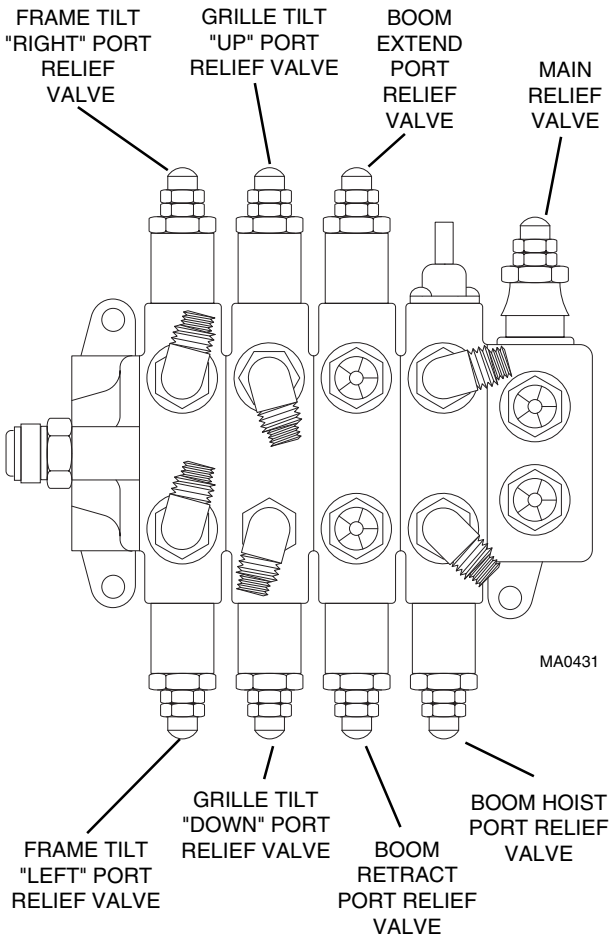

FRAME TILT "RIGHT" PORT RELIEF VALVE
GRILLE TILT "UP" PORT RELIEF VALVE
BOOM EXTEND PORT RELIEF VALVE
MAIN RELIEF VALVE
MA0431
FRAME TILT "LEFT" PORT RELIEF VALVE
GRILLE TILT "DOWN" PORT RELIEF VALVE
BOOM RETRACT PORT RELIEF VALVE
BOOM HOIST PORT RELIEF VALVE

Fig. 9.2 Main Control Valve Relief Valves

Boom Hoist Port Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0 - 4000 psi (275,6 bar) in the tandem pump outlet of the 30 gpm section, Fig. 9.1.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Raise and lower the boom fully several times to purge the system of air.
6. Depress the accelerator to full throttle. Place the joystick in the “raise” position and hold until the hoist cylinders have fully extended. Continue holding the joystick in the “raise” position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 2650 ± 50 psi (182,6 ± 3,4 bar). If not, adjust the boom hoist port relief valve, Fig. 9.2, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13,5 ± 2 N m) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Raise and lower the boom fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

c. Testing

The boom raise/lower circuit should be tested whenever repairs or adjustments are made to components of the circuit.

1. Start the engine, park the forklift on level ground and level the frame.
2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Raise and lower the boom fully several times to purge the system of air if necessary.
4. Starting with the boom fully retracted and at its lowest position, raise the boom at full engine speed. The time required for full hoist should be 11 to 13 seconds (no load).

5. Starting at the fully raised position, lower the boom at full engine speed. The time required to lower the boom to its lowest position should be 8 to 10 seconds (no load).
6. Repeat steps 4 and 5 to recheck performance.
7. If the boom raise/lower circuit test does not meet performance requirements, locate the cause of the problem and correct before putting the vehicle into service.

9.1.2 Boom Extend/Retract

a. Description

Hydraulic pressure is applied in the boom extend/retract circuit by the 30 gpm section (rear half) of the **tandem pump,** which draws its fluid through a suction stainer in the reservoir, Fig. 9.3. Supply pressure is directed to either side of the extend/retract cylinder piston by the shifting of a spool in a directional control valve found in the main control valve assembly. The spool is shifted by the **operator joystick** and its associated control cable. The joystick positions for extending or retracting the boom are as follows:

Center Position

When the joystick is placed in the center or neutral position, the directional control valve spool is positioned so that supply pressure is directed through ports F to C, Fig. 9.3, to the **return filter** and **reservoir**. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

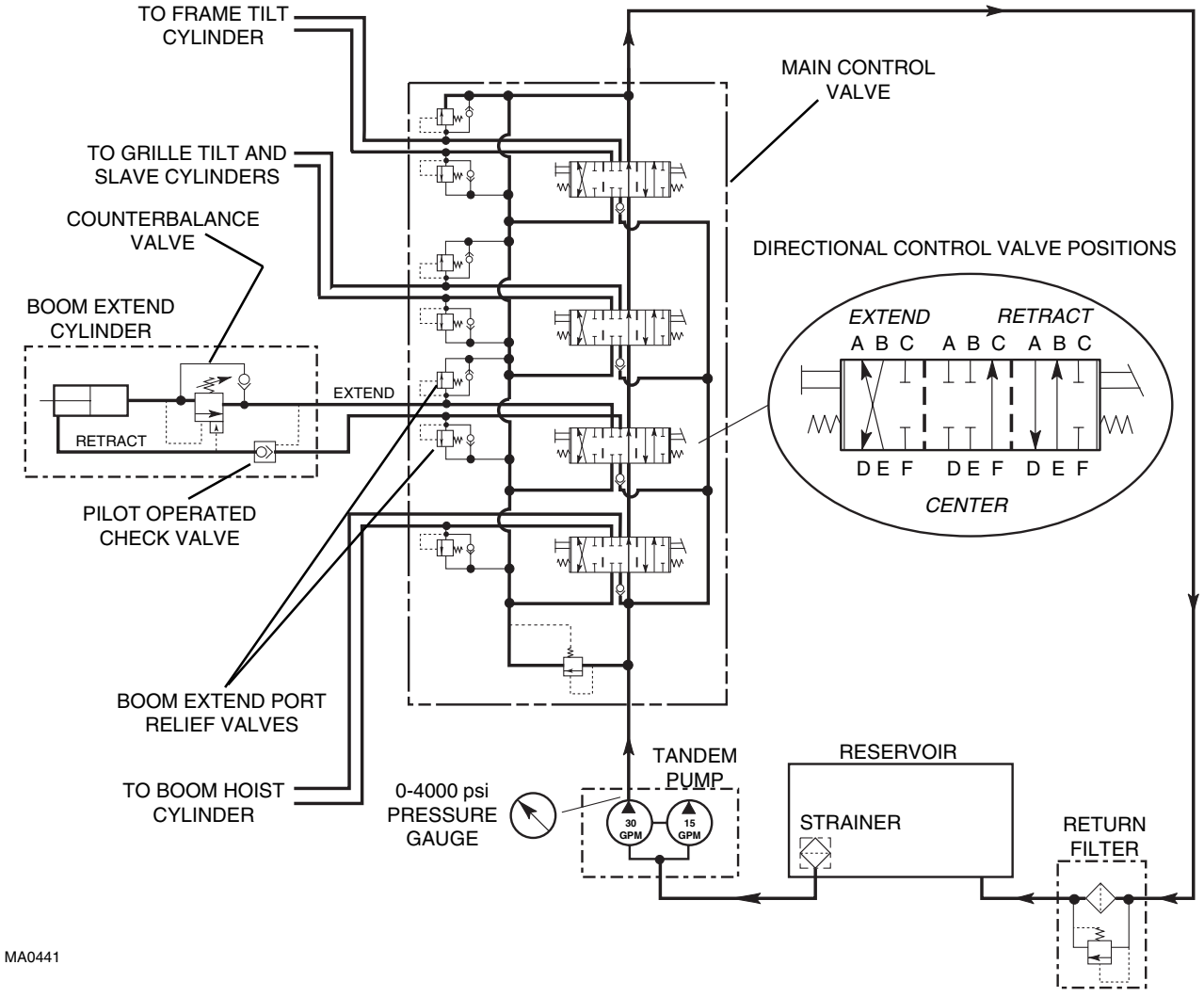


Fig. 9.3 Boom Extend Circuit

Extend Position

When the joystick is placed in the extend position, the directional control valve spool is shifted so that supply pressure is directed through ports E to A, Fig. 9.3, to the base end of the boom extend cylinder piston. If supply pressure reaches 2650 psi (182,6 bar), the **boom extend port relief valve,** Fig. 9.2, will open allowing hydraulic oil to return to the reservoir.

Return oil from the rod side of the extend cylinder piston is directed back to the directional control valve through ports B to D, Fig. 9.3, to the **return filter** and **reservoir**. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

Retract Position

When the joystick is placed in the retract position, the directional control valve spool is shifted so that supply pressure is directed through ports E to B, Fig. 9.3, to the rod side of the boom extend cylinder piston. This supply pressure also pilots open the **counterbalance valve**, Fig. 9.1. The open counterbalance valve allows return oil from the base end of the cylinder to return through ports A to D, Fig. 9.1, of the directional control valve to the **return filter** and **reservoir**. If supply pressure reaches 2650 psi (182,6 bar), the **boom retract port relief valve,** Fig. 9.2, will open allowing hydraulic oil to return to the reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

The **counterbalance valve** in the extend cylinder serves two other main functions. One prevents component damage and the other is for safety. These functions can be described as follows:

- If the machine is traveling and the boom runs into an immovable object, pressure will build up on the base end of the cylinder. If the counterbalance valve was not installed, the rod of the cylinder would bend damaging the cylinder. With the counterbalance valve installed the pressure will build up until it reaches 2650 psi (182,6 bar) and then the counterbalance valve will be internally piloted open allowing the pressure to return to the reservoir. This condition will only exist if the cylinder has been extended. If the cylinder is already fully retracted the counterbalance valve will have no effect and the cylinder rod will bend.
- Should any of the hydraulic lines going to the extend cylinder fail, there will be a loss of hydraulic system pressure to the cylinder. *Example:* If there was a hydraulic line failure in the pressurized retract line during retracting, the counterbalance valve would lose pilot pressure closing off flow returning to the reservoir. The oil in the base end of the cylinder would then be trapped which would immediately stop boom retraction preventing an elevated load from retracting uncontrolled. The load can be lowered safely to the ground by following the “Emergency Boom Lowering” procedures in your Owners/ Operators Manual.

IMPORTANT: *DO NOT attempt to reset the counterbalance valve cartridge. In the event that the counterbalance valve cartridge was disabled for emergency boom lowering or any unauthorized adjustments are ever made to this cartridge, remove and replace the cartridge with a new part. Failure to replace this cartridge with a new part may alter the holding characteristics of the counterbalance valve creating an unsafe condition for machine operation.*

b. Pressure Checks and Adjustments

Boom Extend Port Relief Valve

1. Engage the park lock, place the travel select lever in neutral, level the boom and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0 - 4000 psi (275,6 bar) in the tandem pump outlet of the 30 gpm section, Fig. 9.3.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Extend and retract the boom several times to purge the system of air.
6. Depress the accelerator to full throttle. Place the joystick in the “extend“ position and hold until the extend cylinder has fully extended. Continue holding the joystick in the “extend” position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 2650 ± 50 psi (182,6 ± 3,4 bar). If not, adjust the boom extend port relief valve, Fig. 9.2, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13,5 ± 2 N m) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Extend and retract the boom fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

Boom Retract Port Relief Valve

1. Engage the park lock, place the travel select lever in neutral, level the boom and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0 - 4000 psi (275,6 bar) in the tandem pump outlet of the 30 gpm section, Fig. 9.3.
5. Start the engine. Extend and retract the boom several times to purge the system of air.
6. Depress the accelerator to full throttle. Place the joystick in the “retract” position and hold until the extend cylinder has fully retracted. Continue holding the joystick in the “retract” position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 2650 ± 50 psi (182,6 ± 3,4 bar). If not, adjust the boom retract port relief valve, Fig. 9.2, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13,5 ± 2 N m) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Extend and retract the boom fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

c. Testing

The boom extend/retract circuit should be tested whenever repairs or adjustments are made to components of the circuit.

1. Start the engine, park the forklift on level ground and level the frame.
2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Extend and retract the boom several times to purge the system of air.
4. Starting with the boom fully retracted and level, extend the boom at full engine speed. The time required for full extension should be 12 to 15 seconds (no load).
5. Starting at the fully extended position, retract the boom at full engine speed. The time required to retract the boom fully should be 10 to 13 seconds (no load).

6. Repeat steps 4 and 5 to recheck performance.
7. If the boom extend/retract circuit test does not meet performance requirements, locate the cause of the problem and correct before putting the vehicle into service.

9.1.3 Grille Tilt and Slave Circuit

a. Description

Hydraulic pressure is applied in the grille tilt and slave circuit by the 30 gpm section (rear half) of the **tandem pump,** which draws its fluid through a suction screen in the reservoir, Fig. 9.4. Pressure is directed to either side of the grille tilt and slave cylinder pistons by the shifting of a spool in a directional control valve found in the main control valve assembly. The spool is shifted by the **grille and frame tilt control lever** and its associated control cable. Control lever positions for tilting the grille are as follows:

Center Position

When the grille and frame tilt control lever is placed in the center or neutral position, the directional control valve spool is positioned so that pump supply pressure is directed through ports F to C, Fig. 9.4, to the return **filter** and **reservoir**. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

Up Position

When the grille and frame tilt control lever is placed in the “up” position, the directional control valve spool is positioned so that pump supply pressure is directed through ports E to A, Fig. 9.4, to the base (extend) end of the grille tilt and slave cylinders. The extension of the slave cylinder is fixed by the position of the boom so that only the grille tilt cylinder is extended to tilt the grille up. If supply pressure reaches 2650 psi (182,6 bar), the

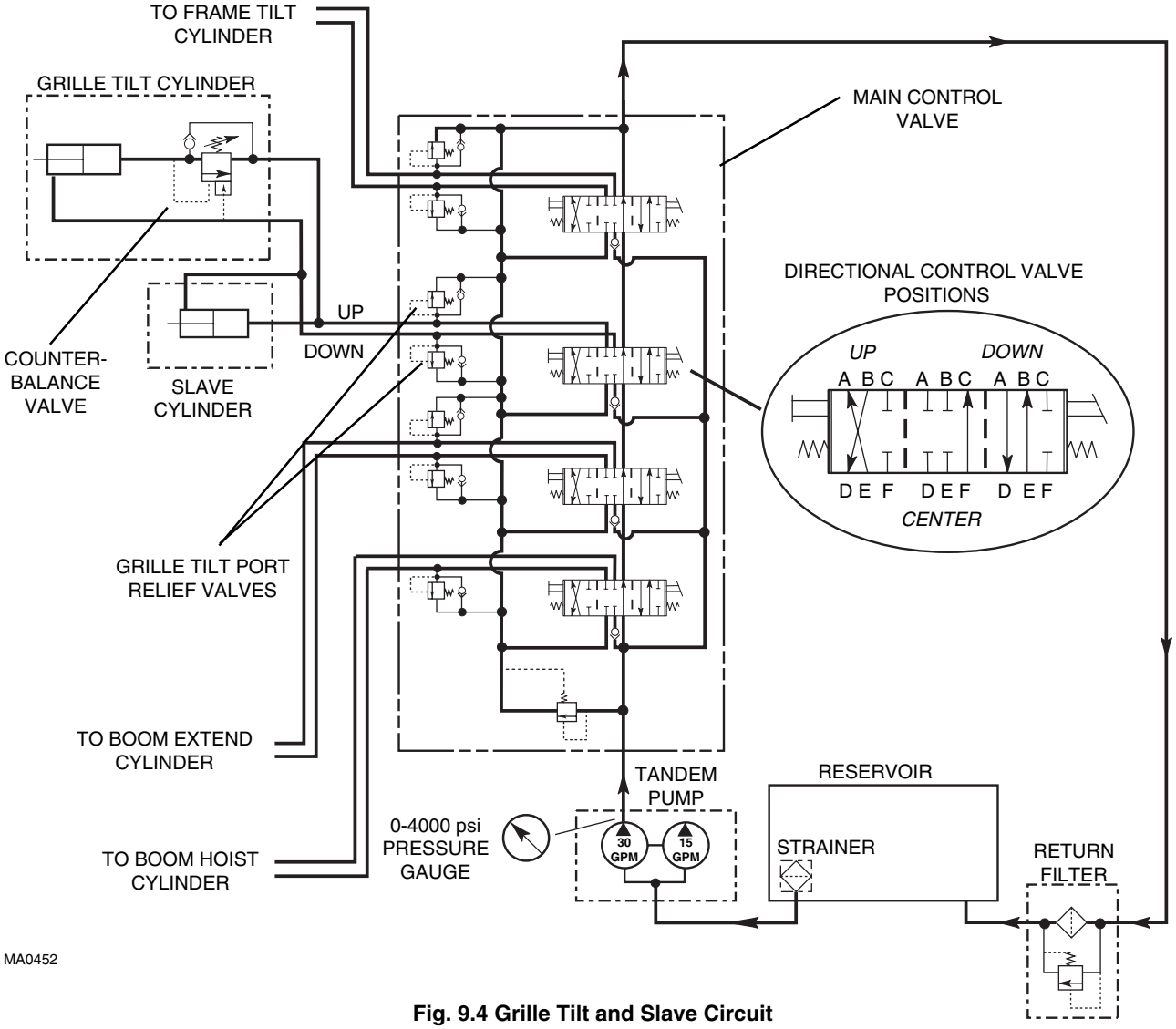


Fig. 9.4 Grille Tilt and Slave Circuit

grille tilt "up" relief valve, Fig. 9.2, will open allowing hydraulic oil to return to the **return filter** and **reservoir**, Fig. 9.4.

Return oil from the rod side of the grille tilt cylinder piston is directed back to the directional control valve through ports B to D, Fig. 9.4, to the return filter and reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

The **counterbalance valve**, Fig. 9.4, will allow oil flow to the base end of the grille tilt cylinder but will not allow reverse oil flow from the base end of the grille tilt cylinder. This prevents the grille from tilting down due to the load on the grille which causes back pressure on the grille tilt cylinder piston. Without this check valve, the back pressure would tilt the grille down if the extend line should fail.

Down Position

When the fork and frame tilt control lever is placed in the "down" position, the directional control valve spool is positioned so that pump supply pressure is directed through ports E to B, Fig. 9.4, to the rod (retract) end of the grille tilt and slave cylinders. The extension of the slave cylinder is fixed by the position of the boom so that only the grille tilt cylinder is retracted to tilt the grille down. This supply pressure also pilots open the **counterbalance valve**, Fig. 9.4. The open check valve allows return oil from the base end of the cylinder to return through ports A to D, Fig. 9.4, of the directional control valve to the r**eturn filter** and **reservoir,** Fig. 9-4. If the supply pressure reaches 2650 psi (182,6 bar), the **grille tilt "down" relief valve,** Fig. 9.2, will open allowing hydraulic oil to return to the return filter and reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

b. Grille Tilt Cylinder, Slave Cylinder and Hoist Cylinder Interaction

The slave cylinder is mounted to the boom in a way that is similar to the hoist cylinders, Fig. 9.4. When the boom is raised or lowered, the movement of the slave cylinder follows the movement of the hoist cylinders. The slave cylinder shares a common extend hydraulic line with the grille tilt cylinder, and also a common retract line. The movements of the cylinders are interactive.

When the boom is raised, the slave cylinder is extended which causes pressure buildup on the rod end of the piston. This pressure pilots open the **counterbalance valve**, Fig. 9.4, and forces hydraulic oil to flow from the rod end of the slave cylinder to the rod end of the grille tilt cylinder and from the base end of the grille tilt cylinder to the base end of the slave cylinder. The grille tilt cylinder rod retracts to tilt the grille down and compensate for upward boom movement. The amount of grille tilt cylinder rod movement is proportional to slave cylinder rod movement to always keep the grille at the same attitude.

When the boom is lowered, the slave cylinder is retracted which causes pressure buildup on the base end of the piston. Hydraulic oil flow and cylinder and grille action are just the reverse of raising the boom. Oil flows through the counterbalance valve without piloting.

c. Pressure Checks and Adjustments

Grille Tilt "Up" Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) at the 30 gpm section of the tandem pump, Fig. 9.4.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Operate the grille tilt control several times to purge the system of air.
6. Depress the accelerator to full throttle. Place the grille and frame tilt control lever in the “up” position and hold until the grille tilt cylinder has fully extended. Continue holding the lever in the “up” position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 2650 ± 50 psi (182,6 ± 3,4 bar). If not, adjust the grille tilt “up” relief valve, Fig. 9.2, turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13,5 ± 2 N m) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Operate the grille tilt control fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

Grille Tilt “Down” Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) at the 30 gpm section of the tandem pump, Fig. 9.4.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Operate the grille tilt control several times to purge the system of air.
6. Depress the accelerator to full throttle. Place the grille and frame tilt control lever in the “down” position and hold until the grille tilt cylinder has fully retracted. Continue holding the lever in the “down” position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 2650 ± 50 psi (182,6 ± 3,4 bar). If not, adjust the grille tilt “down” relief valve, Fig. 9.2, turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13,5 ± 2 N m) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Operate the grille tilt control fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

d. Testing

The grille tilt and slave circuit should be tested whenever repairs or adjustments are made to components of the circuit:

1. Start the engine, park the forklift on level ground and level the frame.
2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Operate the grille tilt control several times to purge the system of air if necessary.
4. Starting with the grille down fully, tilt the grille up fully at full engine speed. The time required for full tilt up should be 4 to 6 seconds (no load).

5. Starting at the full tilt up position, tilt the grille down fully at full engine speed. The time required for full tilt down should be 3 to 5 seconds (no load).
6. Repeat steps 4 and 5 to recheck performance.
7. If the grille tilt circuit test does not meet performance requirements, locate the cause of the problem and correct before putting the vehicle into service

9.1.4 Frame Tilt Circuit

a. Description

Hydraulic pressure is applied in the frame tilt circuit by the 30 gpm section (rear half) of the **tandem pump**, which draws its fluid through a suction screen in the reservoir, Fig. 9.5. Pressure is directed to either side of the frame tilt cylinder piston by the shifting of a spool in a directional control valve found in the main control valve assembly. The spool is shifted by the **grille and frame tilt control lever** and its associated control cable. Control lever positions for tilting the grille are as follows:

Center Position

When the grille and frame tilt control lever is placed in the center or neutral position, the directional control valve spool is positioned so that pump supply pressure is directed through ports F to C, Fig. 9.5, to the **return filter** and **reservoir**. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

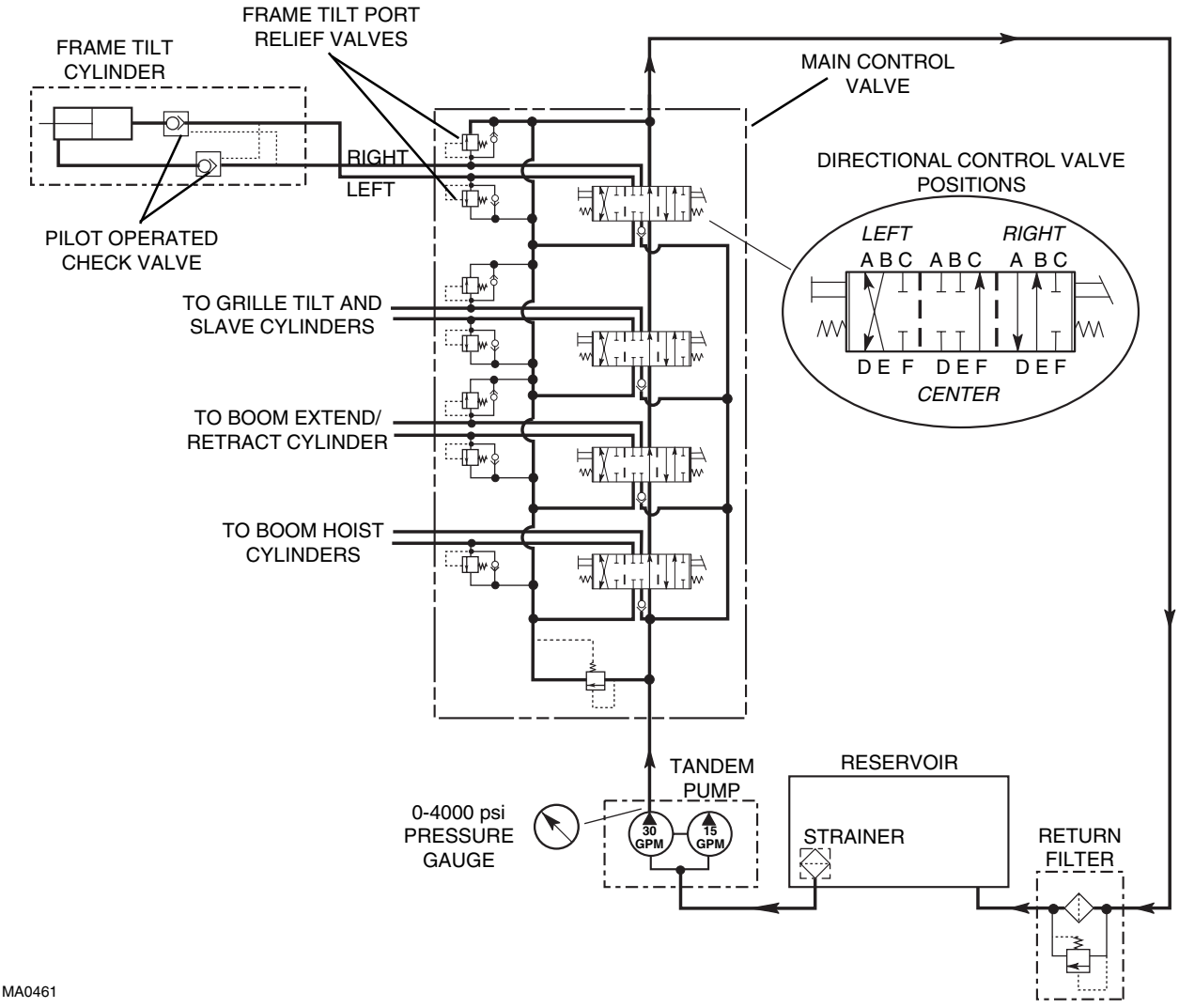


Fig. 9.5 Frame Tilt Circuit

Left Position

When the grille and frame tilt control lever is placed in the “left” position”, the directional control valve spool is positioned so that pump supply pressure is directed through ports E to A, Fig. 9.5, to the base (extend) end of the frame tilt cylinder piston. If supply pressure reaches 1200 psi (82,7 bar), the **frame tilt “left” relief valve,** Fig. 9.2, will open allowing hydraulic oil to return to the **return filter** and **reservoir**, Fig. 9.5.

Return oil from the rod end of the frame tilt cylinder piston is directed back to the directional control valve though ports B to D, Fig. 9.5, to the return filter and reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,0 bar).

Right Position

When the grille and frame tilt control lever is placed in the “right” position, the directional control valve spool is positioned so that pump applied pressure is directed through ports E to B, Fig. 9.5, to the base (retract) end of the frame tilt cylinder piston. If supply pressure reaches 1200 psi (82,7 bar), the **frame tilt “right” relief valve,** Fig. 9.2, will open allowing hydraulic oil to return to the **return filter** and **reservoir**, Fig. 9.5.

Return oil from the base end of the frame tilt cylinder piston is directed back to the directional control valve though ports A to D, Fig 9.5, to the return filter and reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

Pilot-operated check valves, Fig. 9.5, in the frame tilt cylinder permit free flow on both ends of the cylinder piston when supply pressure is applied to open either pilot-operated check valve. When the grille and frame tilt control lever is not activated, no supply pressure is applied. The two check valves prevent any back flow of hydraulic oil and the frame tilt cylinder is locked in position.

b. Pressure Checks and Adjustments

Frame Tilt Left Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) at the 30 gpm section outlet of the tandem pump, Fig. 9.5.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Operate the frame tilt control several times to purge the system of air.
6. Allow engine to run at idle. Place the fork and frame control lever in the “left” position and hold until the frame tilt cylinder bottoms out. Continue holding the lever in the “left” position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 1200 ± 50 psi (82,7 ± 3,4 bar). If not, adjust the frame tilt “left” relief valve, Fig. 9.2, turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13,5 ± 2 N m) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Operate the frame tilt control fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

Frame Tilt Right Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) at the 30 gpm section outlet of the tandem pump, Fig. 9.5.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Operate the frame tilt control several times to purge the system of air.
6. Allow engine to run at idle. Place the fork and frame control lever in the “right” position and hold until the frame tilt cylinder bottoms out. Continue holding the lever in the “right” position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 1200 ± 50 psi (82,7 ± 3,4 bar). If not, adjust the frame tilt “right” relief valve, Fig. 9.2, turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13,5 ± 2 N m) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Operate the frame tilt control fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

c. Testing

The frame tilt circuit should be tested whenever repairs or adjustments are made to components of the circuit :

1. Start the engine, park the forklift on level ground and level the frame.
2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Operate the frame tilt control several times to purge the system of air if necessary.
4. Starting with the frame tilted fully to the left, tilt the frame fully to the right at full engine speed. The time required for frame tilt right should be 8 to 12 seconds (no load).
5. Starting with the frame tilted fully to the right, tilt the frame fully to the left at full engine speed. The time required for frame tilt left should be 7 to 11 seconds (no load).
6. Repeat steps 4 and 5 to check performance.
7. If the frame tilt test does not meet performance requirements, locate the cause of the problem and correct before putting the vehicle into service.

9.1.5 Brake Circuits

a. Description

Hydraulic pressure is normally applied in the service and park lock brake circuits by the 15 gpm section (front half) of the **tandem pump**, which draws its fluid through a suction strainer in the reservoir, Fig. 9.6. A pressure of 575 ± 25 psi (39,6 ± 1,7 bar) is maintained on the service brakes and park lock by the sequence valve. This pressure is reduced to 525 ± 25 psi (36,2 ± 1,7 bar) at the **pressure reducing valve** prior to entering the solenoid-operated **park lock release valve** and pedal-operated **service brake valve**.

Steering and Emergency Brake Pump

The **steering and emergency brake pump**, Fig. 9.6, provides limited backup hydraulic supply pressure to the steering and brake circuits in the event of engine stoppage or tandem pump failure and during initial start-up before the tandem pump is fully operational. This pump is driven by an electric motor; it also draws fluid through the suction strainer in the reservoir.

The steering and emergency brake pump is controlled by a **oil pressure switch** on the engine which senses the engine oil pressure. When the ignition switch is in RUN position and the pressure switch is closed at oil pressure below 4 psi (0,3 bar), the steering and emergency brake pump is energized and the pump will run. Output of the pump is 3 gpm at approximately 1500 psi (104 bar). When the pressure rises above 4 psi (0,3 bar), (engine running), the oil pressure switch opens to stop the steering and emergency brake pump.

Service Brake Valve

When the brake pedal in the operator's cab is **not depressed**, the brake valve spool is spring-

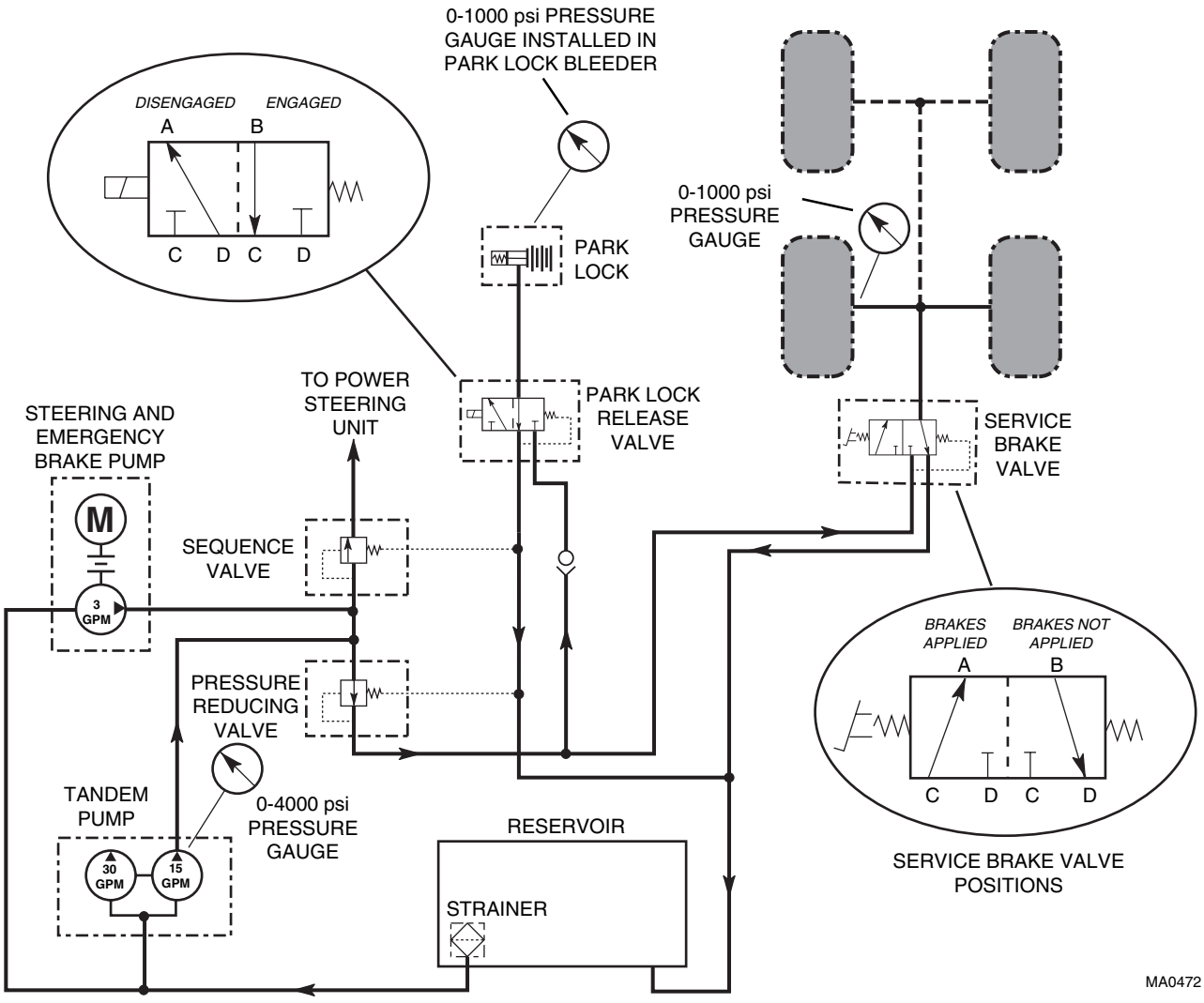


Fig. 9.6 Brake Circuits

positioned so that hydraulic flow is blocked at port C, Fig. 9.6: no pressure is applied to the service brakes. Return flow from the service brakes passes through ports B to D to the reservoir.

When the brake pedal in the operator's cab is **depressed**, the brake valve spool is positioned so that flow is directed through ports C to A, Fig. 9.6, to the service brake pistons. As pressure is applied, the pistons press the brake discs together slowing or stopping the wheel. The brake pedal will return to the up position when released.

Park Lock Release Valve

When the park lock switch on the instrument panel is placed in the **engaged** (up) position, the park lock release valve solenoid is **de-energized** and the valve spool is spring positioned so that hydraulic flow from the park lock piston is directed through ports B to C in the park lock release valve, Fig. 9.6. With no pressure on the park lock piston, the park lock springs force the discs together, this **engages** the park lock. With the park lock release valve solenoid in the **de-energized** position, pressurized hydraulic oil is blocked at port D. The park lock light on the dash will illuminate whenever the park lock is engaged and the ignition switch is in RUN position.

When the park lock switch on the instrument panel is placed in the **disengaged** (down) position, the park lock release valve solenoid is **energized** and the valve spool is positioned so that the hydraulic flow is directed through ports D to A, in the park lock release valve, Fig. 9.6, to the park lock. With hydraulic pressure being applied to the park lock piston, the park lock springs are compressed. Which **disengages** the park lock discs.

IMPORTANT: *Never engage the park lock while the machine is in motion. The park lock is not designed to be used as a means to slow or stop machine travel and could be damaged as a result.*

b. Pressure Checks and Adjustments

Sequence Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) in the 15 gpm section outlet of the tandem pump, Fig. 9.6.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine and allow it to run at idle.
6. Check the pressure gauge reading at the tandem pump.
7. Pressure gauge reading should read 575 ± 25 psi (39,6 ± 1,7 bar). If not, adjust the sequence valve, turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Install the transmission cover after adjustment.

Pressure Reducing Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-1000 psi (68,9 bar) on a service brake, Fig. 9.6.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Install a pressure gauge capable of measuring 1000 psi (68,9 bar) on the park lock bleeder fitting, Fig. 9.6.
6. Start the engine and allow it to idle.
7. Depress the brake pedal and continue to hold until a pressure gauge reading is taken at a service brake.
8. Place the park lock switch in the disengaged (down) position and check the pressure gauge reading at the park lock bleeder fitting.
9. Pressure gauge readings should read 525 ± 25 psi (36,2 ± 1,7 bar). If not, adjust the pressure reducing valve, turning the adjustment screw clockwise to increase or counterclockwise to decrease pressure.
10. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
11. Remove the pressure gauges and tees from the service brake and park lock and reconnect the hydraulic lines.
12. Install the transmission cover after adjustment.

c. Testing

The service brakes should be tested whenever repairs or adjustments are made to components of the circuit.

1. Start the engine, park the forklift on level ground and level the frame.
2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Bleed the brake system as described in paragraph 9.3.2 if necessary.
4. Drive the unloaded forklift down a paved road at road speed in third gear (approximately 11.5 mph).
5. Apply the service brakes. The forklift should stop within 15 feet.
6. Repeat steps 4 and 5 to recheck performance.
7. Park the forklift on level ground and engage the park lock.
8. Place the range select lever in 2nd gear. With the service brakes applied, the forklift should not move when the park lock is disengaged in either forward or reverse.
9. If the service brakes do not meet performance requirements, locate the cause of the problem and correct before putting the vehicle into service.

The park lock should be tested whenever repairs or adjustments are made to park lock components.

1. Start the engine, park the forklift on level ground and level the frame.
2. With the park lock engaged, place range select lever in 2nd gear and travel select lever in “F” (forward). The vehicle should not move when full throttle is applied.
3. With the park lock engaged, place range select lever in 2nd gear and travel select lever in “R” (reverse). The vehicle should not move when full throttle is applied.
4. If the park lock test does not meet performance requirements, locate the cause of the problem and correct before putting the vehicle into service.

9.1.6 Power Steering Circuit

a. Description

1. Hydraulic pressure is applied in the power steering circuit by the 15 gpm section (front half) of the **tandem pump**, which draws its fluid through a **suction strainer** in the **reservoir**, Fig. 9.7.
2. When the steering wheel is turned, the **sequence valve**, Fig. 9.7, opens, permitting supply pressure to be directed to the **power steering unit.** If the supply pressure reaches 2475 ± 25 psi (170,5 ±1,7 bar), the **steering relief valve** will be piloted open to allow hydraulic oil to flow to the **return filter** and **reservoir.**
3. The **power steering unit** consists of control valve and metering sections, Fig. 9.7:

   - The **control valve section** contains a mechanically actuated linear spool which is torsion bar centered and is of the open center type. It directs fluid to and from the metering section and steering cylinders and regulates the pressure supplied to the **steering cylinders**.
   - The **metering section** consists of a commutator and a bidirectional gerotor element. It meters (measures) the amount of fluid sent to the **steering cylinders**.*

*Forklifts S/N 8F0235 and before may have a **counterbalance valve**, Fig. 9.7.

4. The **steering and emergency brake pump**, Fig. 9.7, provides limited backup hydraulic supply pressure to the steering and brake circuits in the event of engine stoppage or tandem pump failure and during initial start-up before the tandem pump is fully operational. This pump is driven by an electric motor; it also draws fluid through the suction strainer in the reservoir.

   The steering and emergency brake pump is controlled by a **oil pressure switch** on the engine which senses the engine oil pressure. When the ignition switch is in RUN position and the pressure switch is closed at oil pressure below 4 psi (0,3 bar), the steering and emergency brake pump is energized and the pump will run. Output of the pump is 3 gpm at approximately 1500 psi (104 bar).

   When the pressure rises above 4 psi (0,3 bar), (engine running), the oil pressure switch opens to stop the steering and emergency brake pump.

No Steering Action

When no steering maneuver is being accomplished, the power steering control valve spool is in the center or neutral position and fluid from the tandem pump circulates through ports F to E, Fig. 9.7, of the control valve section directly back to the reservoir. No fluid is directed to the steer select valve or the steering cylinders.

Left Turn - 2 Wheel Steer

When a left turn is being made with the steering select switch in 2 wheel steer (center position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to B, Fig. 9.7, to the intake side of the power **steering unit** metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports C to D to port J in the **steer select valve**.
3. Both steer select valve solenoids are deenergized. Oil is channeled through ports J to I of the steer select valve to the rod (retract) end of the **right front steering cylinder** and the base (extend) end of the **left front steering cylinder.**
4. Return hydraulic oil from the cylinders flows through ports A to E of the power steering control valve section to the return filter and reservoir.

Left Turn - 4 Wheel Steer

When a left turn is being made with the steering select switch in 4 wheel steer (up position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to B, Fig. 9.7, to the intake side of the **power steering unit** metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports C to D to port J in the **steer select valve**.

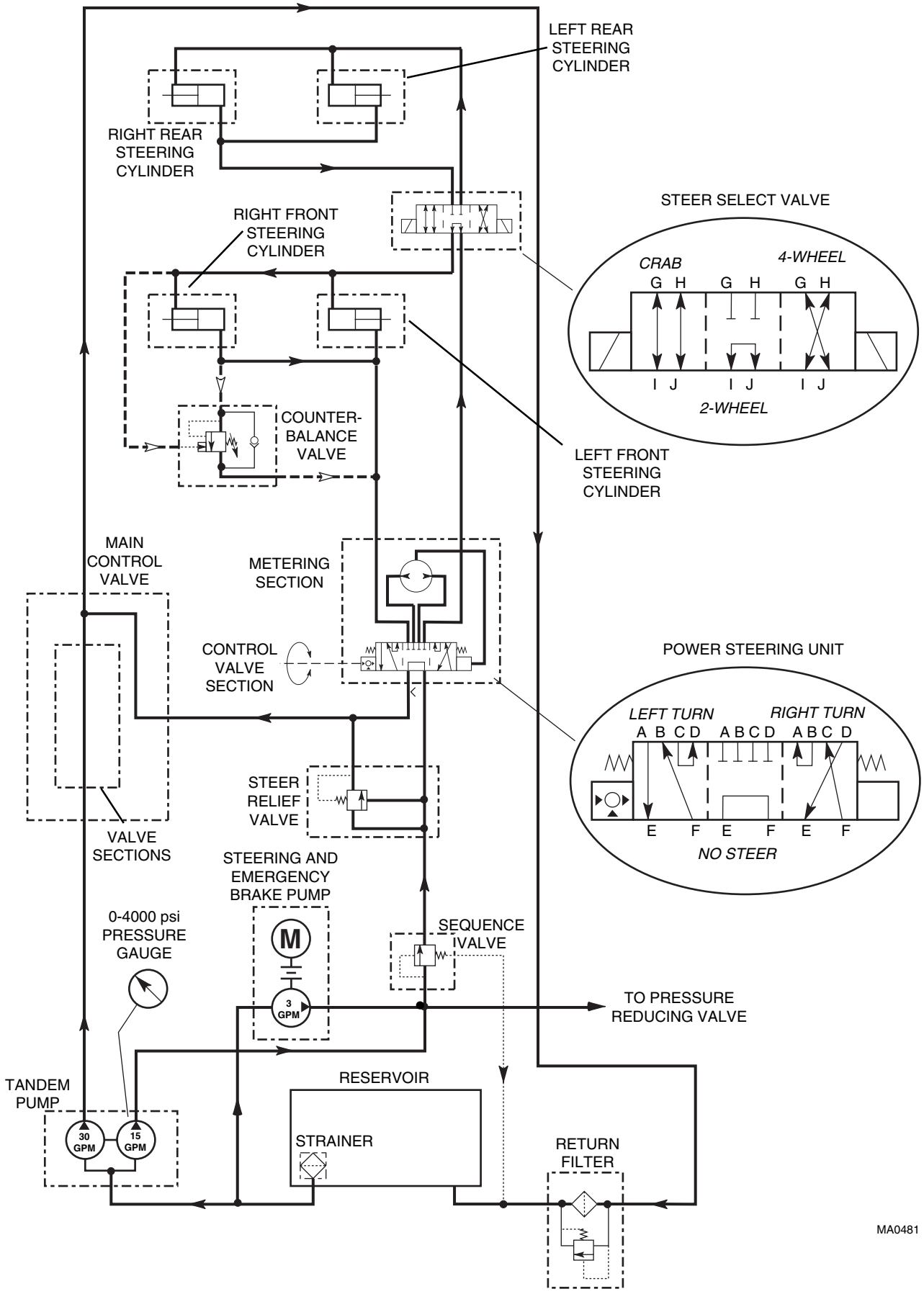


Fig. 9.7 Power Steering Circuit

3. The steer select valve solenoid is energized and shifts the valve spool. Oil is channeled through ports J to G and to the retract side of the **left rear steering cylinder** and the extend side of the **right rear steering cylinder.**
4. Return oil from each of the rear steering cylinders passes through steer select valve ports H to I to the retract side of the **right front steering cylinder** and extend side of the **left front steering cylinder.**
5. Return oil from each of the front steering cylinders flows through ports A to E of power steering control valve section to the return filter and reservoir.

Left Turn - Crab Steer

When a left turn is being made with the steering select switch in crab steer (down position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to B, Fig. 9.7, to the intake side of the power steering metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports C to D to port J in the **steer select valve**.
3. The steer select valve solenoid is energized and shifts the valve spool. Oil is channeled through ports J to H and to the retract side of the **right rear steering cylinder** and the extend side of the **left rear steering cylinder.**
4. Return oil from each of the rear steering cylinders passes through select steer valve ports G to I to the retract side of the **right front steering cylinder** and the extend side of the **left front steering cylinder.**
5. Return oil from each of the front steering cylinders flows through ports A to E of the power steering control valve section to the return filter and reservoir.

Right Turn - 2 Wheel Steer

When a right turn is being made with the steering select switch in 2 wheel steer (center position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to C, Fig. 9.7, to the intake side of the power steering metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports B to A.
3. Supply oil is routed from port A to the extend side of the **right front steering cylinder** and the retract side of the **left front steering cylinder.**
4. Since both steer select valve solenoids are de-energized, return hydraulic oil from the front cylinders circulates through select steer valve ports I to J and power steering control valve section ports D to E to the return filter and reservoir.

Right Turn - 4 Wheel Steer

When a right turn is being made with the steering select switch in 4 wheel steer (up position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to C, Fig. 9.7, to the intake side of the power steering metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports B to A.
3. Supply oil is routed from port A to the extend side of the **right front steering cylinder** and the retract side of the **left front steering cylinder.**
4. Return oil from each of the front steering cylinders passes through the solenoid-energized select steer valve from ports I to H to the retract side of the **right rear steering cylinder** and the extend side of the **left rear steering cylinder.**
5. Return oil from each of the rear steering cylinders flows through steer select valve ports G to J and power steering control valve section ports D to E to the return filter and reservoir.

Right Turn - Crab Steer

When a right turn is being made with the steering select switch in crab steer (down position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to C, Fig. 9.7, to the intake side of the power steering metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve where it is channeled through ports B to A.
3. Supply oil is routed from port A to the extend side of the **right front steering cylinder** and the retract side of the **left front steering cylinder.**

4. Return oil from each of the front steering cylinders passes through the solenoid-energized select steer valve from ports I to G to the extend side of the **right rear steering cylinder** and the retract side of the **left rear steering cylinder.**
5. Return oil from each of the rear steering cylinders flows through select steer valve ports H to J and power steering control valve section ports D to E to the return filter and reservoir.

b. Pressure Checks and Adjustments

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the steering wheel after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) in the 15 gpm section outlet of the tandem pump, Fig. 9.7.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine and allow it to idle (1000 rpm).
6. Turn the steering wheel fully left to right and back (lock to lock) several times in all three steering modes until they operate smoothly. This should purge the steering system of air.
7. Increase engine speed to full throttle and check the pressure gauge reading. It should read between 575 ± 25 psi (39,6 ± 1,7 bar). If not, adjust the sequence valve by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.
8. Turn the steering wheel completely left or right and hold while checking the pressure gauge reading. It should read 2475 ± 25 psi (170,5 ±1,7 bar). If not, adjust the steering relief valve by turning the adjustment screw clockwise to increase relief pressure or counterclockwise to decrease relief pressure.
9. Stop the engine and operate the steering wheel after the engine has stopped to relieve any trapped pressure.
10. Place the ignition switch in RUN position so that steering and emergency brake pump will run. Check the pressure gauge reading (output of pump). Pressure should be 1500 psi minimum.
11. Turn off the ignition. Repeat step 2.
12. If the steering or emergency pump does not work properly, locate the cause of the problem and correct before putting the vehicle into service.
13. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
14. Start the engine. Operate the steering wheel several times to purge the system of air (step 6).
15. Install the transmission cover after adjustment or repair.

9.1.7 Optional Auxiliary Circuit

a. Description

Hydraulic pressure is applied in the optional auxiliary circuit by the 30 gpm section of the **tandem pump**, which draws its fluid through a suction strainer in the reservoir, Fig. 9.8. Supply pressure is directed to either a male or female quick connect at the front of the boom by the shifting of a spool in a **directional control valve** found in the main control valve assembly. The spool is shifted by an **auxiliary control lever** and its associated control cable. The auxiliary circuit supplies hydraulic pressure for use on various hydraulically operated attachments. Auxiliary control lever positions are as follows:

Center Position

When the auxiliary control lever is placed in the center or neutral position, the directional control valve spool is positioned so that supply pressure is applied through ports F to C, Fig. 9.8, to the return filter and reservoir. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

Forward Position

When the auxiliary control lever is placed in the forward position, the directional control valve spool is positioned so that pump applied pressure is directed through ports E to A, Fig. 9.8, to the female auxiliary quick connect coupler. Return pressure is directed through ports B to D to the return filter and reservoir. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

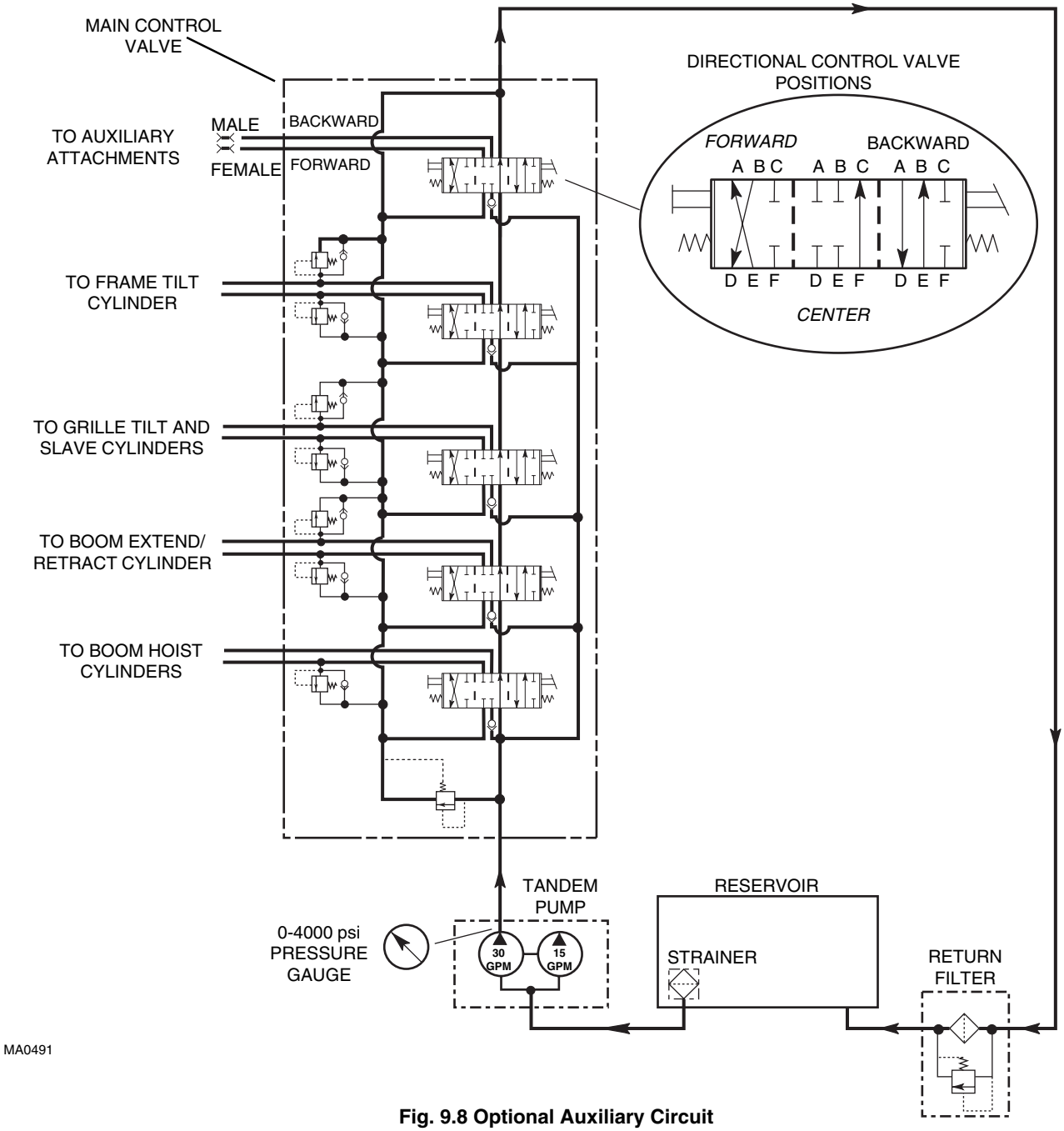


Fig. 9.8 Optional Auxiliary Circuit

Backward Position

When the auxiliary control lever is placed in the backward position, the directional control valve spool is positioned so that pump applied pressure is directed through ports E to B, Fig. 9.8, to the male quick connect coupler. Return pressure is directed through ports A to D to the return filter and reservoir. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

b. Pressure Checks and Adjustments

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) in the 30 gpm section outlet of the tandem pump, Fig. 9.8.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine and maintain engine speed at 1000 rpm.
6. Operate the auxiliary control function several times to purge the system of air.
7. Place the auxiliary control lever in the forward position and hold until the pressure readings are taken.
8. Check the pressure gauge reading. It should read 3,000 ± 50 psi (206,7 ± 3,4 bar).

   If not, adjust the main relief valve, Fig. 9.2, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13,5 ± 2 N m) after adjustment.
9. Place the auxiliary control lever in the backward position and hold until the pressure readings are taken.
10. Check the pressure gauge reading. It should read 3,000 ± 50 psi (206,7 ± 3,4 bar). If not, adjust the main relief valve, Fig. 9.2, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.
11. Stop the engine. Operate the hydraulic control after the engine has stopped to relieve any trapped pressure.
12. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
13. Start the engine. Operate the auxiliary control fully several times to purge the system of air.
14. Install the transmission cover after adjustment.

9.2 CYLINDERS

Rebuild cylinders only in a clean, well lighted area where you can carefully inspect all components. If a cylinder is to remain dismantled for any lengthy period, coat the metal parts that are to be reused with a good preservative and place in protective storage. Refer to specific instructions for removal, rebuilding and installation of each cylinder.

a. General Disassembly Instructions

Warning !

Take care when applying heat to parts to prevent severe burns. Avoid the use of excessive heat which will damage parts and make them unusable.

Some parts of cylinders are sealed with a “special organic” sealant and locking compound. Before you attempt to disassemble these parts, remove any accessible seals from the area of the bonded joint. Wipe off any hydraulic oil and heat the joint uniformly to break the bond. A temperature of 300 to 400 °F (149 to 204 °C) will destroy the bond strength of the sealant. Avoid overheating or the parts may become distorted or damaged. Apply sufficient torque or pressure for removal while parts are still hot. Breakdown of sealant will leave a white powdery residue on threads and parts which must be removed by brushing with a soft brass wire brush prior to reassembly.

Do not attempt to salvage cylinder seals or sealing rings. Any hydraulic component must always be serviced with a complete seal kit during a component rebuild. Repair kits are available.

b. General Cleaning Instructions

Clean all reusable metal parts thoroughly after disassembly and prior to inspection. Use an approved solvent such as trichlorethylene.

c. General Assembly Instructions

1. Before reassembly, be sure parts are clean and free from foreign matter. Use an approved solvent such as trichlorethylene for cleaning.
2. Protect the finish on the rod at all times. Damage to the rod can cause premature seal failure.
3. Use proper tool for specific installation task. Clean tools required for installation before use.
4. Do not overstretch seals, wipers and O-rings. Make sure that seals, wipers and O-rings are not twisted or distorted in their grooves.
5. Lubricate piston seals and seal installation path with clean hydraulic oil from a filtered supply.
6. Use a suitable compression tool when installing glands into cylinders to prevent damage to the seals and O-rings. Place a little hydraulic oil on the seals and outside of glands to aid in installation.
7. Follow the manufacturer’s instructions when applying primer, locking or retaining compounds which are specified in reassembly procedures. The use of primer is recommended in some cases to decrease cure time. Allow sealant compounds to cure fully. The curing process may be hastened by the use of a heat gun to blow warm, dry air on the parts.
8. Following reassembly, test cylinder at low operating pressure to be sure the piston and rod are moving freely in both directions.
9. Increase the operating pressure to the maximum recommended for the cylinder and check for external leakage and free movement in both directions.
10. Prepare cylinder for installation by retracting piston and capping and plugging the ports.

9.2.1 Boom Hoist Cylinder

a. Removal

1. Support the boom, Fig. 9.9, in a horizontal position with blocking.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Engage the park lock, place the travel select lever in neutral, and stop the engine.
3. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
4. Support the cylinder with a sling or other suitable device.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

5. Remove pin and its locking capscrew and lock nut securing the boom hoist cylinder rod to the outer boom.
6. Start the engine and fully retract cylinder.
7. Disconnect the hydraulic lines from the cylinder and cap or plug the open connections.
8. Remove the pin and snap rings securing the boom hoist cylinder to the frame.
9. Remove the cylinder from the forklift using a strap sling and hoist or other suitable lifting equipment.

b. Disassembly of Boom Hoist Cylinder with "TJB" Stamping

1. Remove all dirt and grease from the cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. If necessary to replace, remove the grease fittings (5, Fig. 9.10) and plugs (4 and 6).
4. Remove the counterbalance valve (1) with O-rings (2) and backup rings (3) from the tube (7).

IMPORTANT: *Do not attempt to reset the boom hoist cylinder counterbalance valves. If replacement is necessary, replace both left and right hoist cylinder cartridges at the same time with new ones.*

5. Using a pin spanner wrench, unscrew the gland (14) from the tube.

IMPORTANT: Protect the finish on the rod at all times. *Damage to the surface of the rod can cause premature seal failure.*

6. Pull the rod (17) and attached parts straight out of the tube.

IMPORTANT: *When sliding the rod and piston assembly in the tube, be careful so that gland threads in the tube do not damage the piston (9). Keep the rod in line with the tube barrel to prevent binding.*

7. Remove the piston seal (10) from the piston.
8. Fasten the eye end of the rod (17) in a soft-jawed vise and put a padded support below the rod near the piston to prevent damage to the rod.

NOTE*: It may be necessary to apply heat to break the bond of the sealant between nut (8) and rod (17) before the piston can be removed. Refer to paragraph 9.2a.*

9. Remove the nut (8), piston (9), and gland (14) from the rod.
10. Remove the O-ring (11) from the inside of the piston.

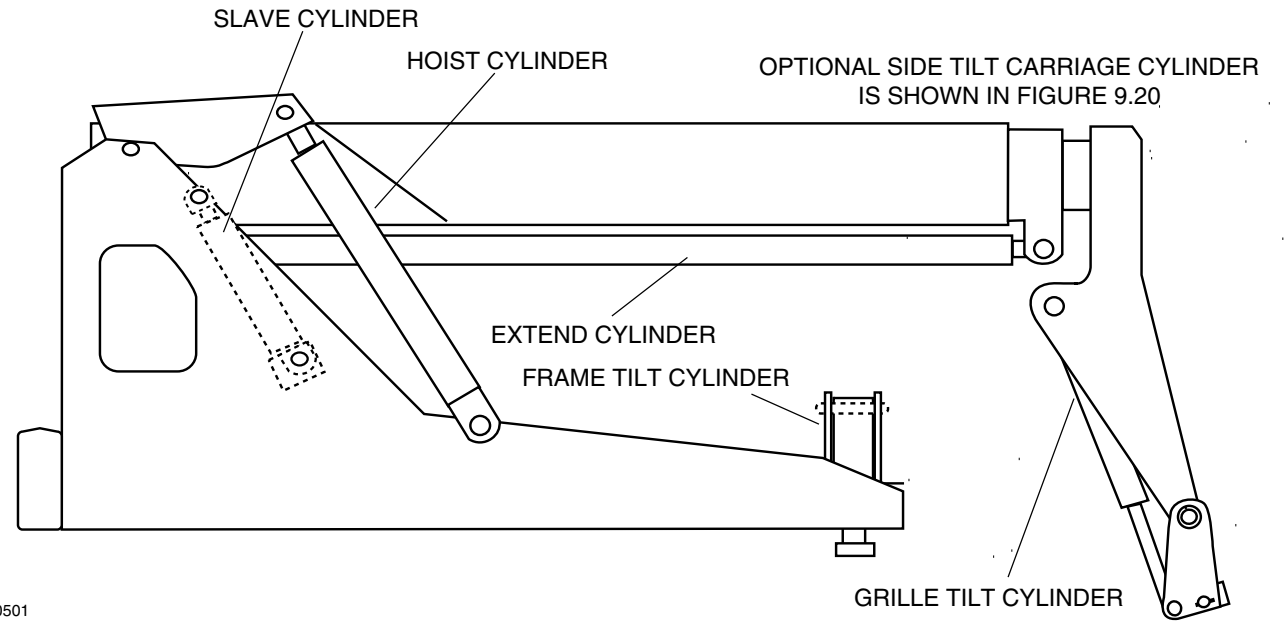


Fig. 9.9 Hydraulic Cylinders

11. Remove the O-ring (12), backup ring (13), wiper (16) and rod seal (15) from the gland.
12. If the bushing (18) needs replacement, support the rod (17) in a soft-jawed vise or other acceptable holding equipment. Carefully press or drive bushing from the rod eye.

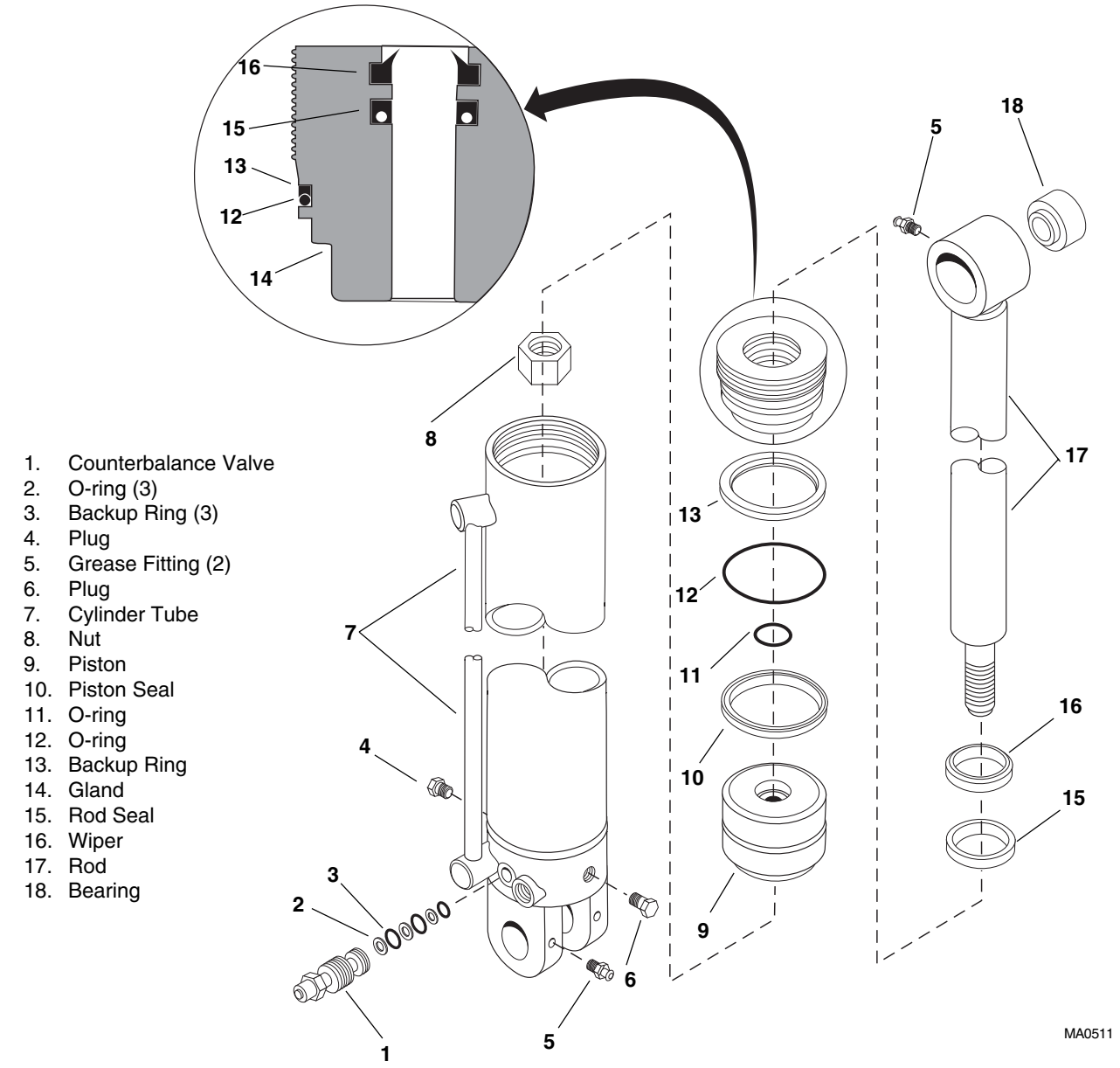
***NOTE**: It may be necessary to apply heat to break the bond of the sealant between bushing (18) and rod (17) before the bushing can be removed. Refer to paragraph 9.2a.*

c. Cleaning

1. Discard <u>all</u> seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that the rod (17, Fig. 9.10) is straight. If the rod is bent, install new rod.



1. Counterbalance Valve
2. O-ring (3)
3. Backup Ring (3)
4. Plug
5. Grease Fitting (2)
6. Plug
7. Cylinder Tube
8. Nut
9. Piston
10. Piston Seal
11. O-ring
12. O-ring
13. Backup Ring
14. Gland
15. Rod Seal
16. Wiper
17. Rod
18. Bearing

Fig. 9.10 Boom Hoist Cylinder Exploded View

2. Inspect the inside of the tube (7) for scoring and other damage. If the tube is damaged, replace with new tube.
3. Remove small scratches on the rod or inside the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut (8) and the bottom of piston (9) with a fine file. Clean parts with trichlorethylene after repair.

e. Assembly

***NOTE**: Follow general assembly instructions in paragraph 9.2c.*

1. Apply Loctite® Primer T and Retaining Compound 609 to the outside diameter of the bushing (18, Fig. 9.10) in accordance with the manufacturer's instructions. Press the bushing into position in the eye of rod so that the bushing is located an equal distance from each side of the rod eye. Allow the compound to cure.
2. Install a new rod seal (15), wiper (16), backup ring (13) and O-ring (12) on the gland (14) as shown in Fig. 9.10.

***NOTE:** The wiper lips should be toward the outer end of the gland and the rod seal lips toward the inner end of the gland. Use tools that will not damage the seal or wiper. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.*

3. Fasten the rod eye in a soft-jawed vise. Put a padded support below and near the other end of the rod to prevent damage to the rod.
4. Push the assembled gland onto the rod (17). If necessary, use a soft hammer to drive the gland onto the rod.
5. Install new O-ring (8) into internal groove on the inside of the piston (9). Carefully push the piston (6) onto the rod to avoid damage to the O-ring.
6. Apply Loctite® Primer T and Threadlocker 271 to the threads on the nut (8) in accordance with the manufacturer's instructions. Install the nut on the rod and torque to 575 to 625 lb-ft (782 to 850 N m). Stake the nut in four places. Allow the Threadlocker to cure.
7. Install a new piston seal (10) on the piston.
8. Fasten the tube (7) in a soft-jawed vise or other acceptable holding equipment. Be careful not to damage the tube.
9. Lubricate the inside of the tube, outside of the piston, seal (10) and O-ring (12) with clean hydraulic oil.
10. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (12) on the gland. Insert the assembled piston, rod and gland into the tube (7). Using a pin spanner wrench, thread the gland into tube. Remove the compression tool

***IMPORTANT**: When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.*

11. Install new O-rings (2) and backup rings (3) on counterbalance valve (1). Use new valve if the valve was removed for replacement. Lubricate outside of the valve with clean filtered hydraulic oil. Install the valve and torque to 45 lb-ft (61,2 N m).
12. If removed for replacement, install new plugs (4 and 6) and grease fittings (5).
13. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
14. Increase the operating pressure to the maximum (4000 psi or 275,6 bar) for the cylinder and check for external leakage and free movement in both directions.
15. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Lubricate the hoist cylinder pivot pins with multi-purpose lithium-based grease
2. Using suitable lifting device, install the boom hoist cylinder, Fig. 9.9, on the forklift securing the base end to the frame with pivot pin and snap rings.
3. Remove all plugs or caps from hydraulic lines and securely tighten lines to the cylinder.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Have a helper start the forklift engine.
5. Position the hoist cylinder so that the rod is aligned with the rod end mounting holes as much as possible.
6. Instruct the operator to raise or lower the hoist cylinder slowly until the rod end eye is aligned with the outer boom mounting holes. Secure the rod end to the boom with pivot pin and its locking capscrew and locknut.
7. Raise the boom as far as it will go; then lower it as far as it will go five times or until the operation of the boom hoist cylinders is normal (no jerks or spongy feel).
8. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
9. Test boom hoist/lower circuit operation as described in paragraph 9.1.1c.

9.2.2 Boom Extend Cylinder

a. Removal

1. Retract the boom and support it in a horizontal and level position with blocking.
2. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

3. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

4. Disconnect the hydraulic lines from the extend cylinder and cap or plug open connections.
5. Remove the anti-buckle bar, Fig. 9.11.
6. Support the extend cylinder with a sling or other suitable device.
7. Remove the rod end pin and retaining rings attaching the rod end of the extend cylinder to the intermediate boom.
8. Remove the base end pin and retaining rings securing the base end of the cylinder to the outer boom.
9. Remove the cylinder from the forklift using a strap sling and hoist or other suitable equipment.

b. Disassembly

1. Remove all dirt and grease from the cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. Remove the counterbalance valve (14, Fig. 9.12), pilot check valve (15) and related O-rings (18) and backup rings (19) from the tube (13).

IMPORTANT: *Do not attempt to reset the extend cylinder counterbalance valve cartridge. If replacement is necessary, replace the cartridge with a new one.*

4. Using a pin spanner wrench, unscrew the gland (12, Fig. 9.13) from the tube (13).

IMPORTANT: Protect the finish on the rod at all times. *Damage to the surface of the rod can cause premature seal failure.*

5. Pull the rod and piston assembly straight out of the tube.

IMPORTANT: *When sliding the rod and piston assembly out of the tube, be careful so that gland threads in the tube do not damage the piston (5). Keep the rod in line with the tube barrel to prevent binding.*

6. Remove piston seal (4) from the piston.

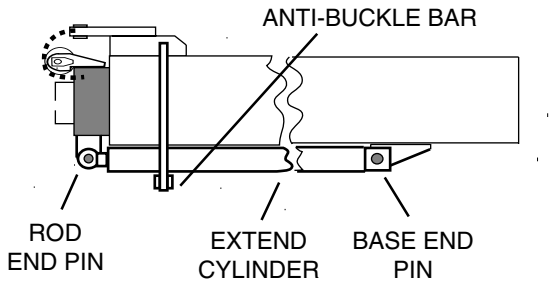


Fig. 9.11 Boom Extend Cylinder Removal

NOTE: *It may be necessary to apply heat to break the bond of the sealant between piston (5), setscrew (6) and rod (1) before the piston can be removed. Refer to paragraph 9.2a.*

7. Remove setscrew (6) and nylon setscrew (7) securing piston (5) in place on rod (1).
8. Unscrew the piston from rod. Remove O-ring (8) from inside of the piston.
9. Slide stop tube (9) and gland (12) from the rod.
10. Remove O-ring (10), backup ring (11), wiper (2), rod seal (3), and step seal (17) from the gland.
11. If necessary, remove the plugs (16) from bottom inside of the tube (13)

c. Cleaning

1. Discard <u>all</u> seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that the rod (1, Fig. 9.12) is straight. If the rod is bent, install new rod.

1. Rod
2. Wiper
3. Rod Seal
4. Piston Seal
5. Piston
6. Setscrew
7. Setscrew (Nylon)
8. O-ring
9. Stop Tube
10. O-ring
11. Backup Ring
12. Gland
13. Cylinder Tube
14. Counterbalance Valve
15. Pilot Check Valve
16. Plug (2)
17. Step Seal
18. O-ring (6)
19. Backup Ring (6)

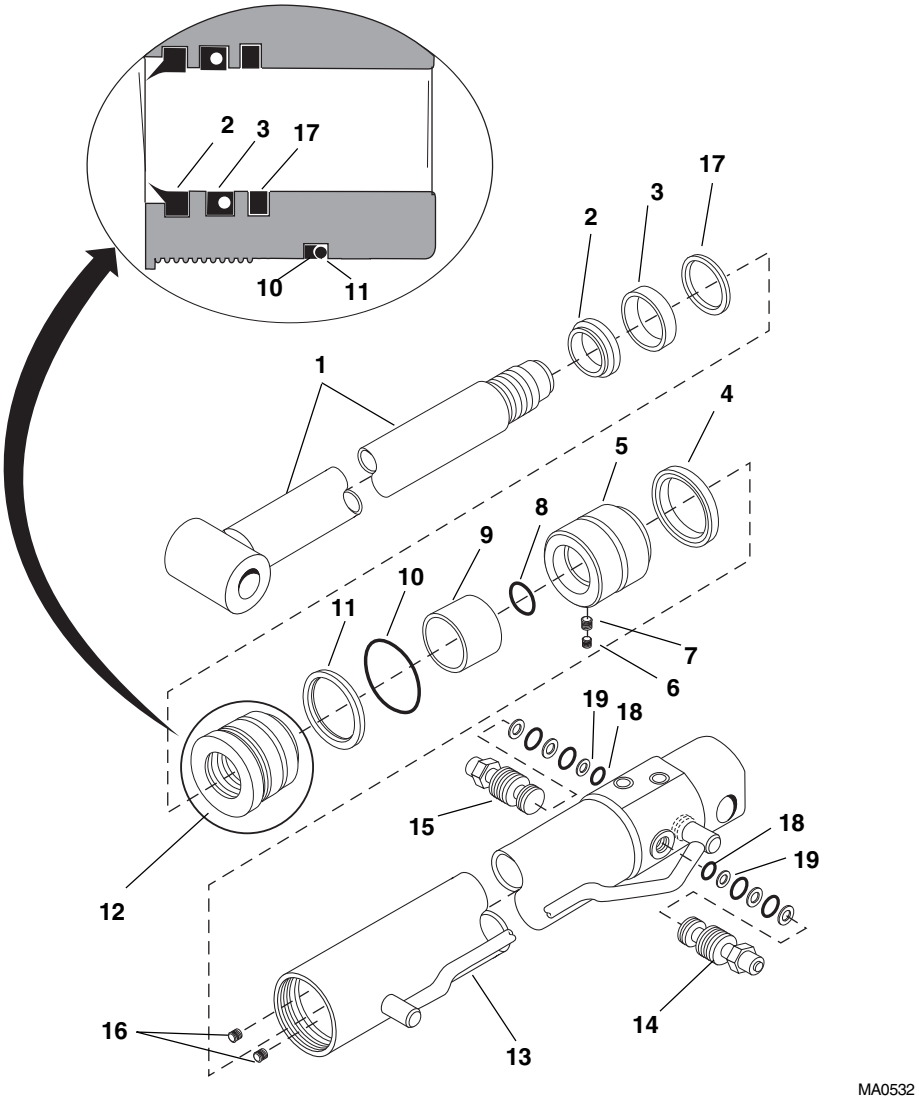


Fig. 9.12 Boom Extend Cylinder Exploded View

2. Inspect inside of the tube (13) for deep scoring and other damage. If the tube is damaged, replace with new tube.
3. Remove small scratches on the rod or inside the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.

e. Assembly

***NOTE**: Follow general assembly instructions in paragraph 9.2c.*

1. Install a new O-ring (10), backup ring (11), wiper (2), rod seal (3), and step seal (17) on the gland as shown in Fig. 9.12.

***NOTE:** Wiper lip should be toward outer end of gland and rod seal lips (3) and the step of step seal (17) toward the inner end of the gland. Use tools that will not damage the seals. If the backup ring (11) is not flat on both sides, the side with the arc must be toward O-ring (10).*

2. Fasten the rod eye in a soft-jawed vise. Place a padded support below and near end of rod to prevent damage to rod (1).
3. Slide the assembled gland and seals onto the rod. If necessary, use a soft hammer to drive the gland on the rod.
4. Slide the stop tube (9) onto the rod.
5. Install new O-ring (8) inside internal groove on inside of piston (5).
6. Apply Loctite® Primer T and Compound 609 to inside threads of piston in accordance with manufacturer's instructions. Carefully screw piston completely onto the rod.
7. Apply Loctite® Threadlocker 242 to setscrews (6 and 7) and install them in the piston.
8. Apply Loctite® Primer T and Compound 609 to outside diameter of rod next to piston. Slide stop tube (9) down the rod and against the piston. Allow sealants to cure.
9. Install new piston seal (4) on piston.
10. Fasten cylinder tube (13) in a soft-jawed vise or other acceptable holding equipment.
11. If removed, install two plugs (16) in the bottom of the cylinder tube.
12. Lubricate inside of the tube and outside of the piston and gland with clean hydraulic oil.
13. Apply a compression sleeve or other suitable tool to the gland in order to compress O-ring (10) on the gland. Insert the assembled piston, rod and gland into the tube (13). Using a pin spanner wrench, thread the gland into tube. Remove the compression tool.

***IMPORTANT:** When sliding the rod and piston assembly in the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.*

14. Install new O-rings (18) and backup rings (19) on the counterbalance valve (14) and pilot check valve (15). Use new valves if either or both valves were removed for replacement. Lubricate outside of the valves with clean filtered hydraulic oil. Install the valves and torque them to 45 lb-ft (61,2 N m).
15. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
16. Increase the operating pressure to the maximum (4000 psi or 275,6 bar) for the cylinder and check for external leakage and free movement in both directions.
17. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Using suitable lifting device, install the boom extend cylinder, Fig. 9.9, on the forklift securing the base end of the extend cylinder to the outer boom with a pin and retaining rings.
2. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

3. Have a helper start the forklift engine.
4. Position the extend cylinder so that the rod is aligned with the rod end mounting holes as much as possible.
5. Instruct the operator to extend or retract the cylinder slowly until the rod end eye is aligned with the intermediate boom mounting holes. Secure the rod end to the boom with pin and retaining rings.
6. Install the anti-buckle bar, Fig. 9.11.

7. Extend the boom as far as it will go; then the retract it as far as it will go five times or until the operation of the boom extend cylinder is normal (no jerks or spongy feel).
8. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
9. Test boom extend/retract circuit operation as described in paragraph 9.1.2c.

9.2.3 Slave Cylinder

a. Removal

1. Raise the boom as required to provide access to the slave cylinder, Fig. 9.9.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
4. Support the slave cylinder with a sling or other suitable device
5. Remove the capscrew and locknut securing the slave cylinder rod to the outer boom.
6. Start engine and fully retract slave cylinder.
7. Disconnect the hydraulic lines from the cylinder and cap or plug open connections.
8. Remove the retaining ring and pin securing the slave cylinder tube to the frame.
9. Remove the cylinder from the forklift using a strap sling and hoist or other suitable lifting equipment.

b. Disassembly

1. Remove all dirt and grease from cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. If necessary to replace, remove grease fittings (13 and 14, Fig. 9.13)

NOTE: *It may be necessary to apply heat to break the bond of the sealant between bushings (1) and rod (12) and tube (2) before the bushings can be removed. Refer to paragraph 9.2a.*

4. Carefully press or drive out the bushings (1).
5. Using a pin spanner wrench, unscrew the gland (4) from the cylinder tube (2).

IMPORTANT: Protect the finish on the rod at all times. *Damage to the surface of the rod can cause premature seal failure.*

6. Pull the rod (12) and attached parts straight out of the tube.

IMPORTANT: *When sliding the rod and piston assembly out of the tube, be careful so that gland threads in the cylinder tube do not damage the piston (9). Keep the rod in line with the tube barrel to prevent binding.*

7. Remove the piston seal (8) from the piston .
8. Fasten the eye end of the rod in a soft-jawed vise and put a padded support below and near the other the end of the rod to prevent damage to the rod.

NOTE: *It may be necessary to apply heat to break the bond of the sealant between nut (3) and rod (12) before the piston can be removed. Refer to paragraph 9.2a.*

9. Remove the nut (3), piston (9), and gland (4) from the rod.
10. Remove the O-ring (7) from inside of the piston.
11. Remove the O-ring (6), backup ring (5), wiper (11) and rod seal (10) from the gland (4).

c. Cleaning

1. Discard all seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that the rod (12, Fig. 9.13) is straight. If the rod is bent, install new rod.
2. Inspect inside of the tube (2) for scoring and other damage. If there is any damage to tube, replace it with new tube.
3. Remove small scratches on the rod or inside the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut (3) and the bottom of piston (9) with fine file. Clean parts with trichlorethylene after repair.

e. Assembly

NOTE: *Follow general assembly instructions in paragraph 9.2c.*

1. Install new O-ring (6, Fig. 9.13), backup ring (5), wiper (11), and rod seal (10) on the gland (4) as shown in Fig. 9.13.

NOTE: *Wiper lip should be toward outer end of gland and piston seal lips toward the inner end of the gland. Use tools that will not damage the seal. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.*

1. Bushing (2)
2. Cylinder Tube
3. Locknut
4. Gland
5. Backup Ring
6. O-ring
7. O-ring
8. Piston Seal
9. Piston
10. Rod Seal
11. Wiper
12. Rod
13. Grease Fitting
14. Grease Fitting (90°)

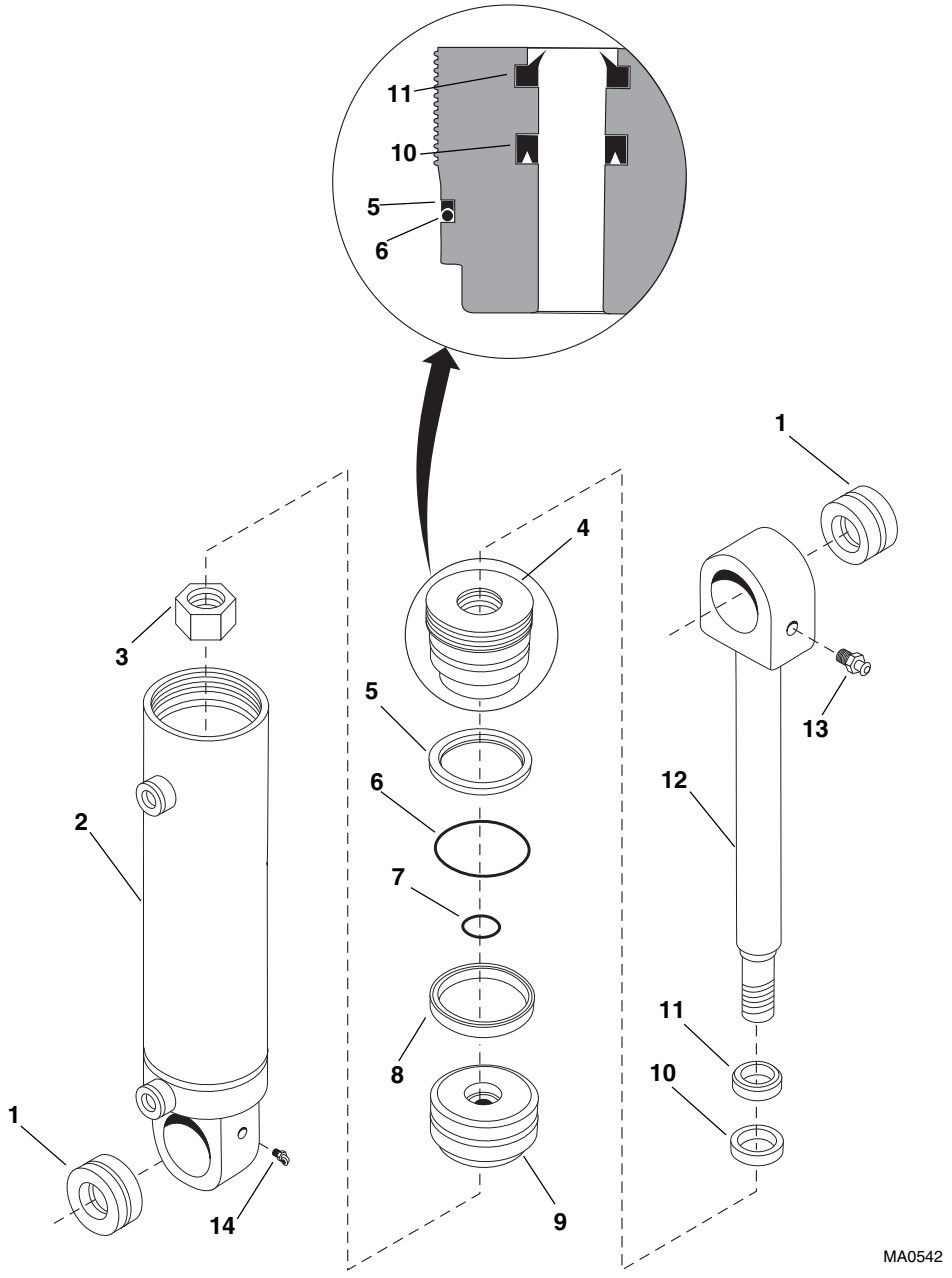


Fig. 9.13 Slave Cylinder Exploded View

2. Fasten the piston rod eye in a vise and put a padded support below and near other end of rod to prevent damage to the rod.
3. Push the assembled gland onto the rod (12). If necessary, use a soft hammer to drive the gland on the rod.
4. Install new O-ring (7) inside of piston (9). Carefully install piston on rod to avoid damage to the O-ring.
5. Apply Loctite® Primer T and Retaining Compound 271 to the threads of the locknut (3) in accordance with the manufacturer's instructions. Install the nut on the rod and torque to 450 to 500 lb-ft (612 to 680 N m). Stake the nut in four places and allow sealants to cure.
6. Install new piston seal (8) on the piston.
7. Fasten cylinder tube (2) in a soft-jawed vise or other suitable holding equipment. Be careful not to damage the tube.
8. Lubricate inside of the tube, piston, and gland O-ring (6) with clean hydraulic oil.
9. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (6) on the gland. Insert the assembled piston, rod and gland into the tube (2). Using a pin spanner wrench, thread the gland into the tube. Remove the compression tool.

IMPORTANT: *When sliding the rod and piston assembly in the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.*

10. Apply Loctite® Primer T and Retaining Compound 609 to outside diameter of bushings (1) in accordance with manufacturer's instructions. Press bushings into both the eye of rod and eye of cylinder tube so that the bushing is located an equal distance from each side of the rod eye. Allow the compound to cure.
11. If removed, install grease fittings (13 and 14).
12. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
13. Increase the operating pressure to the maximum (4000 psi or 275,6 bar) for the cylinder and check for external leakage and free movement in both directions.
14. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Lubricate the pivot pin with multi-purpose lithium-based grease.
2. Using suitable lifting device, install the slave cylinder, Fig. 9.9, on the forklift securing the base end to the frame with a pin and snap rings.
3. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Have a helper start the forklift engine.
5. Position the slave cylinder so that the rod is aligned with the rod end mounting holes as much as possible.
6. Instruct the operator to extend or retract the cylinder slowly until the rod end eye is aligned with the outer boom mounting holes. Secure the slave cylinder to the outer boom with its locking capscrew and locknut.
7. Tilt grille (forks) up fully, then down fully and then approximately level. Raise the boom as far as it will go; then lower it as far as it will go five times while observing the grille. The grille should hold in the same position during boom raising and lowering in the last two cycles.
8. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
9. Test grille tilt circuit operation as described in paragraph 9.1.3c.

9.2.4 Grille Tilt Cylinder

a. Removal

1. Remove any attachment from the quick attach assembly.
2. Tilt the quick attach assembly fully forward and lower it, face down, to the ground
3. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

4. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

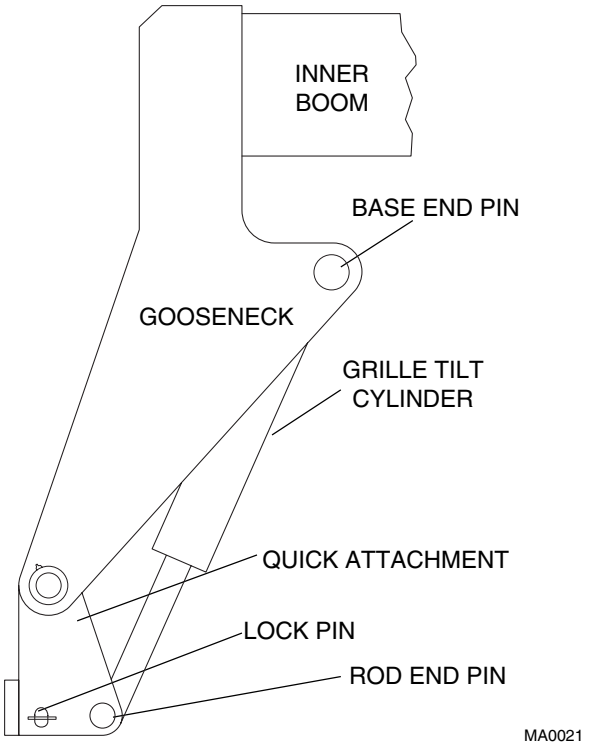


Fig. 9.14 Grille Tilt Cylinder Gooseneck

5. Remove the rod end pin, Fig. 9.14, and its locking capscrew and locknut securing the grille tilt cylinder rod to the quick attach.
6. Start the engine and fully retract grille tilt cylinder.
7. Disconnect the hydraulic lines from the cylinder and cap or plug open connections.
8. Remove the pin and snap rings securing the grille tilt cylinder tube to the gooseneck.
9. Remove cylinder from forklift using strap sling and hoist or other suitable lifting equipment.

b. Disassembly

1. Remove all dirt and grease from cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. If necessary to replace, remove the grease fittings (14 and 15).
4. Remove the counterbalance valve (13, Fig. 9.15) and three O-rings (16) and backup rings (17) from the tube.
5. Using a pin spanner wrench, unscrew the gland (8) from the tube.

IMPORTANT: Protect the finish on the rod at all times. *Damage to the surface of the rod can cause premature seal failure.*

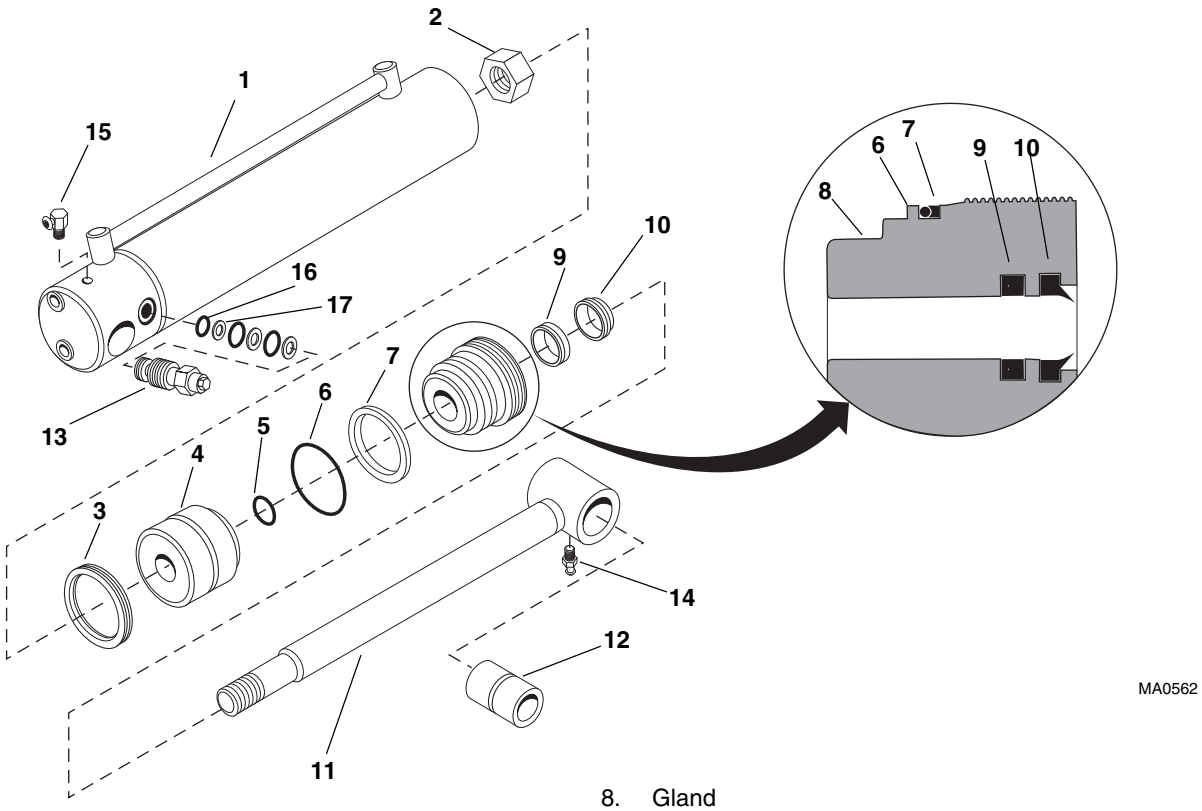
6. Pull the rod (11) and attached parts straight out of the tube.

IMPORTANT: *When sliding the rod and piston assembly in the tube, be careful so that gland threads in the tube do not damage the piston (4). Keep the rod in line with the tube barrel to prevent binding.*

7. Remove piston seal (3) from piston (4).
8. Fasten the eye of the rod in a soft-jawed vise and put a padded support below and near other end of rod to prevent damage to the rod.

NOTE: *It may be necessary to apply heat to break the bond of the sealant between nut (2) and rod (11) before the piston can be removed. Refer to paragraph 9.2a.*

9. Remove nut (2), piston (4), and the gland (8) from the rod.
10. Remove the O-ring (5) from inside of the piston.
11. Remove the O-ring (6), backup ring (7), wiper (10) and rod seal (9) from the gland.



1. Cylinder Tube
2. Nut
3. Piston Seal
4. Piston
5. O-ring
6. O-ring
7. Backup Ring
8. Gland
9. Rod Seal
10. Wiper
11. Rod
12. Bushing
13. Counterbalance Valve
14. Grease Fitting
15. Grease Fitting (90°)
16. O-ring (3)
17. Backup Ring (3)

Fig. 9.15 Grille Tilt Cylinder Exploded View

12. If the bushing (12) needs replacement, support the rod (11) in a soft-jawed vise or other acceptable holding device. Carefully press the bushing from the rod.

c. Cleaning

1. Discard all seals and backup rings. Replace them with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that the rod (11, Fig. 9.14) is straight. If the rod is bent, install new rod.
2. Inspect inside of the tube (1) for scoring and other damage. If there is any damage to the tube, replace it with a new tube.
3. Remove small scratches on piston rod or inside of tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut (2) and bottom of the piston (4) with a fine file. Clean parts with trichlorethylene after repair.

e. Assembly

***NOTE**: Follow general assembly instructions in paragraph 9.2c.*

1. Press the bushing (12, Fig. 9.15) into position in the eye of the rod (11) so that the grease groove runout is located toward the center of the eye.
2. Install new O-ring (6), backup ring (7), wiper (10), and rod seal (9) on the gland (8) as shown in Fig. 9.15.

NOTE: *Wiper lip should be toward outer end of gland and seal lips toward the inner end of the gland. Use tools that will not damage the seals. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.*

3. Fasten the eye of the rod in a soft-jawed vise. Put a padded support below and near end of rod to prevent damage to the rod.
4 Push the assembled gland onto the rod (11). If necessary, use a soft hammer to drive the gland onto the rod.
5. Install new O-ring (5) inside of piston (4). Carefully install the piston on the rod to avoid damage to the O-ring.
6. Apply Loctite® Primer T and Threadlocker 271 to the nut (2) in accordance with the manufacturer's instructions. Install the nut on the piston rod and torque to 450 to 500 lb-ft (612 to 680 N m). Stake the nut in four places. Allow the compound to cure.
7. Install new piston seal (3) on the piston.
8. Fasten the tube (1) in a soft-jawed vise or other acceptable holding equipment. Be careful not to damage the tube.
9. Lubricate inside of the cylinder tube, piston, and gland O-ring (6) with clean hydraulic oil.
10. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (6) on the gland. Insert the assembled piston, rod and gland into the tube (1). Using a pin spanner wrench, thread the gland into the tube. Remove the compression tool

IMPORTANT*: When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.*

11. Install new O-rings (16) and backup rings (17) on the counterbalance valve (13). Use new valve if the valve was removed for replacement. Lubricate outside of the valve with clean filtered hydraulic oil. Install the valve and torque to 45 lb-ft (61,2 N m).
12. If removed, install grease fittings (14 and 15).
13. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,8 bar) to be sure the piston and rod are moving freely in both directions.
14. Increase the operating pressure to the maximum (4000 psi or 275,6 bar) for the cylinder and check for external leakage and free movement in both directions.
15. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Lubricate the rod end pin with a good grade of multi-purpose lithium-based grease.
2. Using a suitable lifting device, install the grille tilt cylinder, Fig. 9.9, on the forklift securing the tube end to the gooseneck, Fig. 9.14, with a pin and snap rings.
3. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Have a helper start forklift engine.
5. Position the grille tilt cylinder so that the rod is aligned with the rod end mounting holes in quick attach as much as possible.
6. Instruct the operator to extend or retract the cylinder slowly until the rod end eye is aligned with the quick attach mounting holes. Secure the rod end of the cylinder to the quick attach with pin, capscrew and locknut.
7. Raise the boom up so that you can observe the grille. Tilt the grille all the way back, then all the way forward. Repeat this cycle at least five times or until the operation of the grille tilt circuit is normal (no jerking or spongy feel).
8. Tilt grille (forks) up fully, then down fully and then approximately level. Raise the boom as far as it will go; then lower it as far as it will go five times while observing the grille. The grille should hold in the same position during boom raising and lowering in the last two cycles.
9. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
10. Test grille tilt circuit operation as described in paragraph 9.1.3c.

9.2.5 Frame Tilt Cylinder

a. Removal

1. Level the frame. Place blocking between frame and axle to maintain machine stability when frame tilt cylinder is removed.
2. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

3. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
4. Remove the snap rings locking the rod end pin in the axle mounting block. Tap the pin from the mounting block.
5. Start the engine and fully retract the frame tilt cylinder. Then shut engine OFF.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

6. Disconnect the hydraulic lines from cylinder and cap or plug open connections.
7. Remove the pin, shims, capscrew, and locknut securing the frame tilt cylinder tube to the frame, Fig. 9.16.
8. Remove the frame tilt cylinder from the forklift using a strap sling and hoist or other suitable equipment.

b. Disassembly

1. Remove all dirt and grease from cylinder.
2. Fasten the frame tilt cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. Remove both check valves (1, Fig. 9.17) and related O-rings (15) and backup rings (16).
4. Using a pin spanner wrench, unscrew the gland (8) from the tube.

IMPORTANT: Protect the finish on the rod at all times. *Damage to the surface of the rod can cause premature seal failure.*

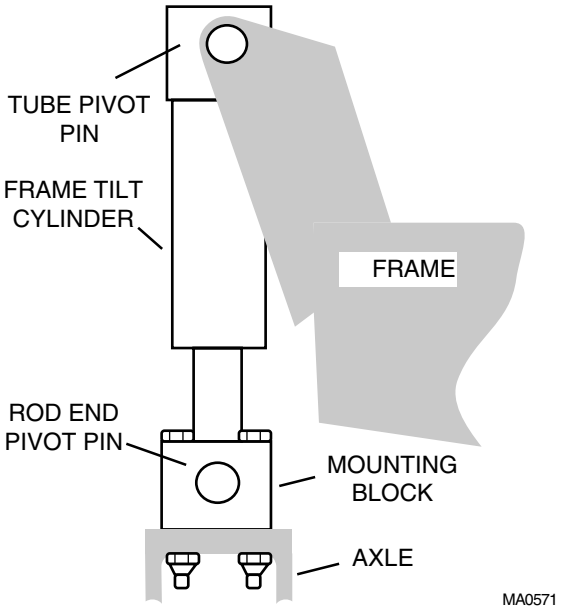


Fig. 9.16 Frame Tilt Cylinder Pivot Pins

5. Pull the rod (13) and attached parts straight out of the tube.

IMPORTANT: *When sliding the rod and piston assembly in the tube, be careful so that gland threads in the tube do not damage the piston (5). Keep the rod in line with the tube barrel to prevent binding.*

6. Fasten the eye of rod (13) in a soft-jawed vise and put a padded support below and near other end of the rod to prevent damage to the rod.
7. Remove piston seal (10) piston.

NOTE*: It may be necessary to apply heat to break the bond of the sealant between nut (4) and rod (13) before the piston can be removed. Refer to paragraph 9.2a.*

8. Remove nut (4), piston (5), and the gland (8) from the rod.
9. Remove O-ring (6) from inside of the piston.
10. Remove O-ring (9), backup ring (10), wiper (12) and rod seal (11) from the gland.
11. If necessary to replace, remove grease fittings (14) and plugs (2).

c. Cleaning

1. Discard all seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that rod (13, Fig. 9.17) is straight. If the rod is bent, install new rod.
2. Inspect inside of the tube (3) for scoring and other damage. If the tube is damaged, replace with new tube.
3. Remove small scratches on the rod or inside of the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut (4) and the bottom of the piston (5) with a fine file. Clean parts with trichlorethylene after repair.

e. Assembly

***NOTE**: Follow general assembly instructions in paragraph 9.2c.*

1. If removed, install the plugs (2) and grease fittings (14).
2. Install new O-ring (9, Fig. 9.17), backup ring (10), wiper (12), and rod seal (11) on gland (8) as shown in Fig. 9.17.

1. Check Valve (2)
2. Plug (2)
3. Cylinder Tube
4. Nut
5. Piston
6. O-ring
7. Piston Seal
8. Gland
9. O-ring
10. Backup Ring
11. Rod Seal
12. Wiper
13. Rod
14. Grease Fitting (2)
15. O-ring (6)
16. Backup Ring (6)

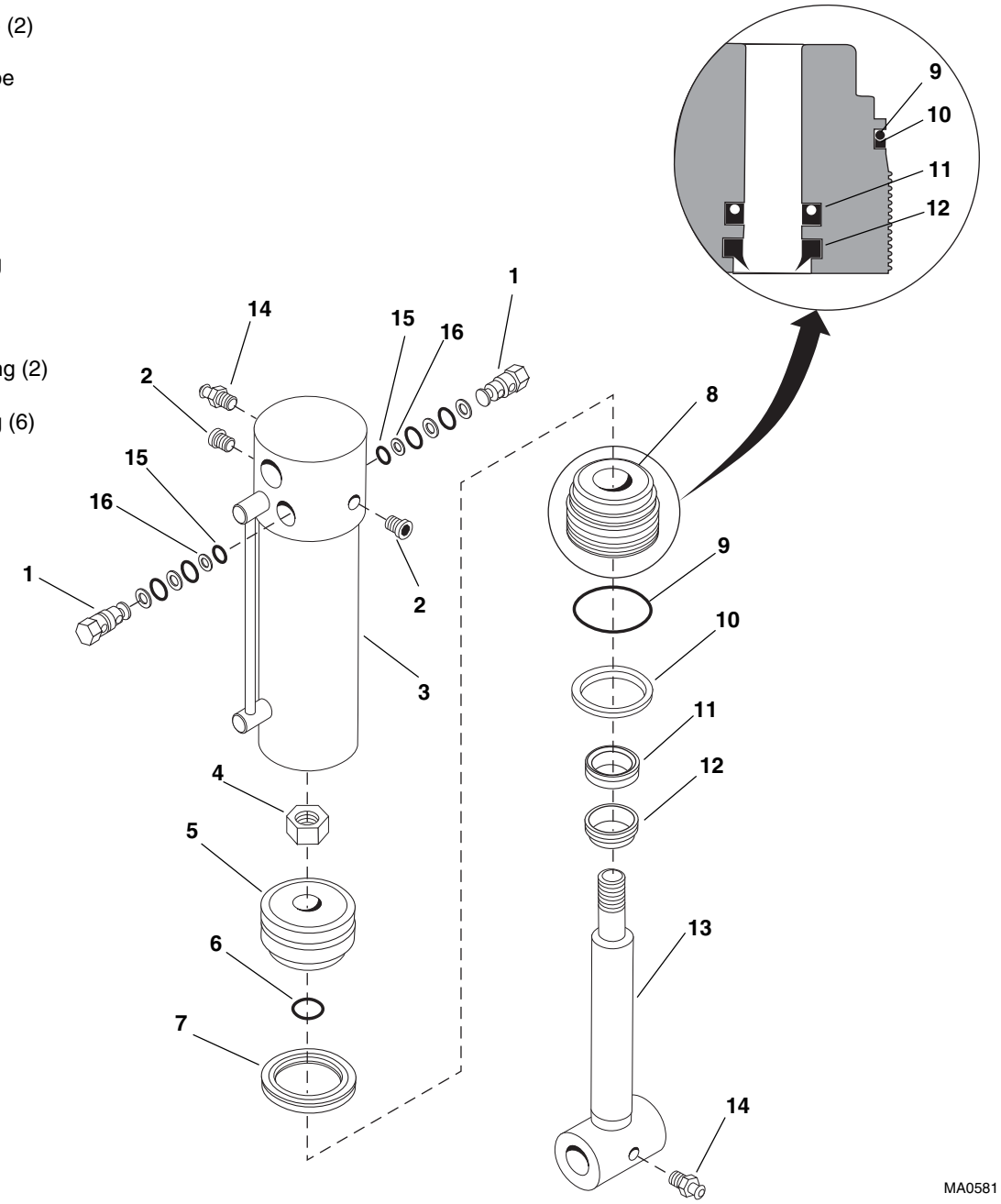


Fig. 9.17 Frame Tilt Cylinder Exploded View

NOTE: *The wiper lip should be toward the outer end of the gland and seal lips toward the inner end of the gland. Use tools that will not damage the seals. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.*

3. Fasten the eye of the rod eye in a soft-jawed vise and put a padded support below the other end of the rod to prevent damage to the rod.
4. Push the assembled gland onto the rod (13). If necessary, use a soft hammer to drive the gland onto the rod.
5. Install new O-ring (6) inside of the piston (5).
6. Install the piston on rod.
7. Apply Loctite® Primer T and Threadlocker 271 to the nut (2) in accordance with the manufacturer's instructions. Install the nut on the rod and torque to 400 to 450 lb-ft (544 to 612 N m). Stake the nut in four places.
8. Install a new piston seal (7) on the piston.
9. Fasten the cylinder tube (3) in a soft-jawed vise or other acceptable holding equipment. Be careful not to damage the tube.
10. Lubricate the inside of the tube, piston, and gland O-ring (9) with clean hydraulic oil.
11. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (9) on the gland. Insert the assembled piston, rod and the gland into the tube (3). Using a pin spanner wrench, thread the gland into the tube. Remove the compression tool

IMPORTANT*: When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.*

12. Install new O-rings (15) and backup rings (16) on check valves (1). Use new valves if either valve was removed for replacement. Lubricate outside of the valves with clean filtered hydraulic oil. Install the valves and torque to 30 to 35 lb-ft (40,8 to 47,6 N m).
13. If removed, install plugs (2) and grease fittings (14).
14. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
15. Increase the operating pressure to the maximum (4000 psi or 275,6 bar) for the cylinder and check for external leakage and free movement in both directions.
16. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Lubricate the frame tilt cylinder pivot pins with multi-purpose lithium-based grease
2. Using suitable lifting device, install the frame tilt cylinder, Fig. 9.9, on the forklift securing the tube end to the axle mounting block with pivot pin, shims, locking capscrew and locknut.
3. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Have a helper start the forklift engine.
5. Position the frame tilt cylinder so that the base end is aligned with the rod end mounting holes in the frame as much as possible.
6. Instruct the operator to extend or retract the frame tilt cylinder slowly until the base end eye is aligned with the frame mounting holes. Secure the base end to the frame with pivot pin and snap rings.
7. Remove blocking from between axle and frame.
8. Using the fork and frame tilt control lever, tilt the frame full right, then full left at least five complete cycles or until operation of the frame tilt circuit is normal (no jerking or spongy feeling).
9. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
10. Test frame tilt circuit operation as described in paragraph 9.1.4c.

9.2.6 Steering Cylinder

a. Removal

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

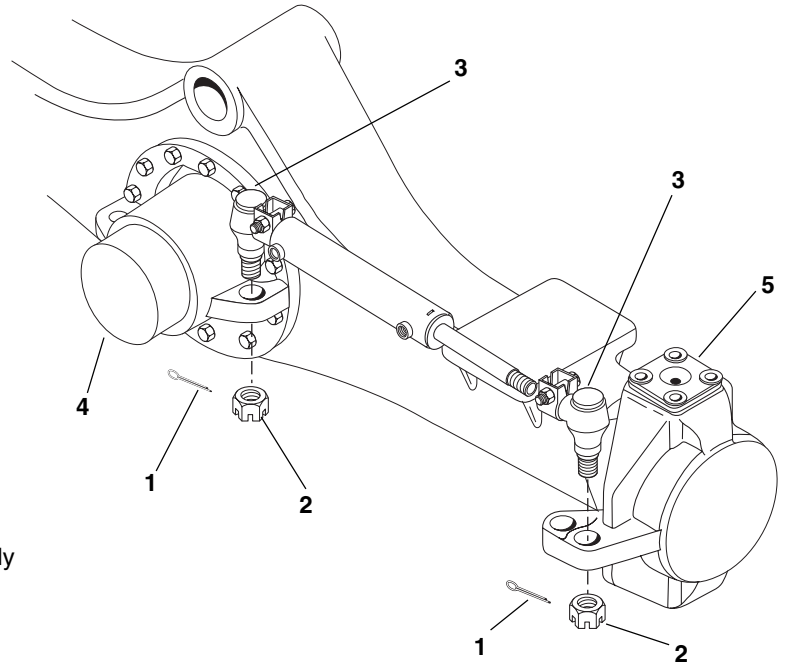
Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Disconnect the hydraulic lines from the steering cylinder and cap and plug open connections.
4. Remove cotter pins (1, Fig. 9.18) and nuts (2) securing the cylinder socket assemblies (3) to carrier (4) and knuckle (5).
5. The steer cylinder socket is a taper fit in knuckle. Use an impact fork to release the socket from the knuckle.
6. Remove the cylinder from the forklift using a strap sling and hoist or other suitable lifting equipment.
7. Measure the total length of the fully retracted cylinder with sockets in place and note or record the distance. Loosen socket clamps and unscrew the socket assemblies from the cylinder.

b. Disassembly

1. Remove all dirt and grease from the steering cylinder
2. Determine the direction that the gland (4, Fig. 9.19) will be turning when it is removed so that the lockwire (10) will feed out through the tube hole.
3. Using a sharp object, such as a screwdriver, pry up one end of the lockwire from its hole in the tube (1).
4. Using a spanner wrench, remove the gland allowing the lockwire to work its way out of the tube.

IMPORTANT: Protect the finish on the rod at all times. *Damage to the surface of the rod can cause premature seal failure.*



1. Cotter pin (2)
2. Nut (2)
3. Cylinder Socket Assembly
4. Carrier
5. Knuckle

Fig. 9.18 Steering Cylinder Installation

5. Pull rod (3) and attached parts straight out of the tube.

***NOTE**: It may be necessary to apply heat to break the bond of the sealant between locknut (11) and rod (3) before the piston can be removed. Refer to paragraph 9.2a.*

6 Remove locknut (11), piston (2), and gland (4) from the rod (3).

7. Remove rod wiper (5), Z-seal (6), and O-ring (7) from the gland.

8. Remove O-ring (8) and crown seal (9) from the piston.

c. Cleaning

1. Discard <u>all</u> seals and lockwire. Replace with a complete new seal kit.

2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that rod (3, Fig. 9.19) is straight and undamaged. If the rod is bent or damaged, install new rod.

2. Inspect inside of tube (1) for scoring and other damage. If there is any damage to the tube, replace it with a new tube.

1. Tube
2. Piston
3. Rod
4. Gland
5. Rod Wiper
6. Z-seal
7. O-ring
8. O-ring
9. Crown Seal
10. Lockwire
11. Locknut

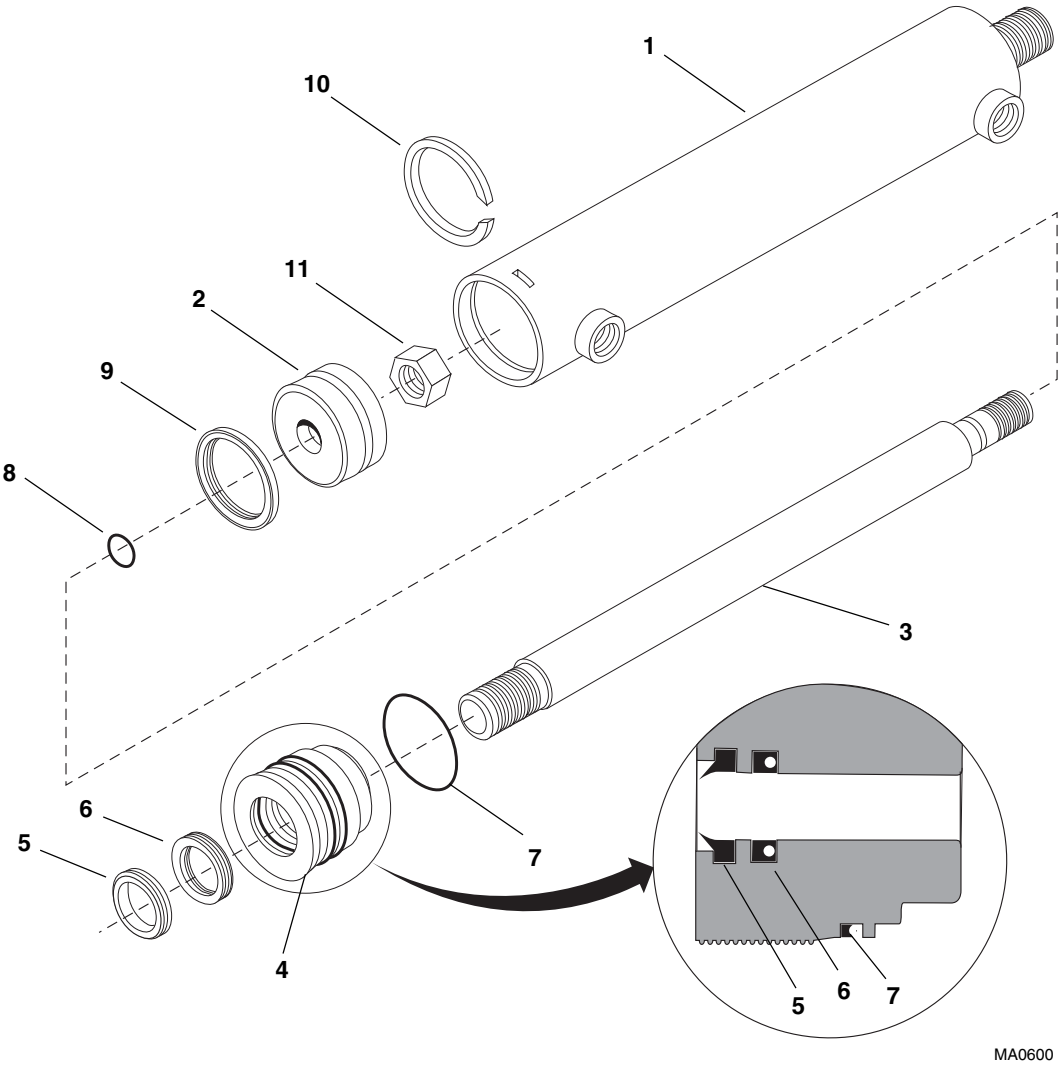


Fig. 9.19 Steering Cylinder Exploded View

3. Remove small scratches on inside of the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.

e. Assembly

***NOTE**: Follow general assembly instructions in paragraph 9.2c.*

1. Fasten rod (3) in a soft-jawed vise.
2. Install new O-ring (8, Fig. 9.19) inside of piston (2). Carefully install the piston on rod (3) to avoid damage to the O-ring.
3. Apply Loctite® Primer T and Threadlocker 271 to the locknut (11) in accordance with the manufacturer's instructions. Install the locknut and torque it to 90 to 100 lb-ft (122,4 to 136,0 N m). Allow sealants to cure.
4. Install crown seal (9) on piston (2).
5. Install rod wiper (5), Z-seal (6), and O-ring (7) on the gland (4).
6. Install the assembled gland and seals on rod (3).
7. Lubricate all parts and inside of the tube (1) with clean hydraulic oil.
8. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (7) on the gland. Push the rod assembly straight into the cylinder tube with a steady even pressure until the gland butts up against the tube.
9. Locate the hole in the tube and insert lockwire (10).
10. Using a spanner wrench, rotate the gland 360 degrees to install the lockwire.
11. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
12. Increase the operating pressure to the maximum (4000 psi or 275,6 bar) for the cylinder and check for external leakage and free movement in both directions.
13. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Screw the socket assemblies (3, Fig. 9.18) onto the retracted cylinder (4). Adjust position of the socket assemblies by turning them until the total length equals the measured length taken during removal.

***NOTE**: If there is no accurate recorded cylinder length, the cylinder can be adjusted as described in the following steps.*

2. Turn the steering knuckle to full inside turn position on either the left or right side.
3. Adjust the socket assembly position in or out on the rod end, and also the barrel end if necessary, so that the retracted length of the cylinder matches the length required to install the cylinder

***IMPORTANT: Protect the finish on the rod at all times.** Damage to the surface of the rod can cause premature seal failure.*

4. Install nuts (2) securing the cylinder socket assemblies to the axle carrier (4) and knuckle (5). Torque the nuts to 140 lb-ft (190 N m) minimum. Install cotter pins (1).
5. Tighten the socket clamps. Torque the clamp bolts and nuts to 60 to 70 lb-ft (82 to 95 N m).
6. Turn the other steering knuckle to its full inside turn position and adjust the cylinder (steps 3 through 5).
7. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

8. Start the engine. Turn the steering wheel fully left to right and back (lock to lock) several times in all three steering modes until they operate smoothly. This should purge the steering system of air. The maximum number of turns of the steering wheel should not exceed 4-1/2 turns lock to lock.
9. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
10. Test steering circuit operation as described in paragraph 9.1.6c.

9.2.7 Side Tilt Carriage Cylinder (Optional)

a. Removal

1. Place the boom in a horizontal position.
2. Using the side tilt control lever, tilt the carriage fully to the left to retract the side tilt cylinder.
3. Support the side tilt carriage (7, Fig. 9.20) in this position with blocking.
4. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

5. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

6. Remove all dirt and grease from side tilt carriage cylinder (1) and hydraulic lines (2 and 3).
7. Disconnect the hydraulic lines from the cylinder and cap and plug the open connections.
8. Remove snap ring (4) and cylinder rod pin (5) securing the side tilt carriage cylinder rod to side tilt carriage (7).
9. Remove snap rings (4) and cylinder base pin (6) securing the side tilt carriage cylinder tube to pivot base (8).
10. Remove the cylinder from the pivot base using a strap sling and hoist or other suitable lifting equipment.

b. Disassembly

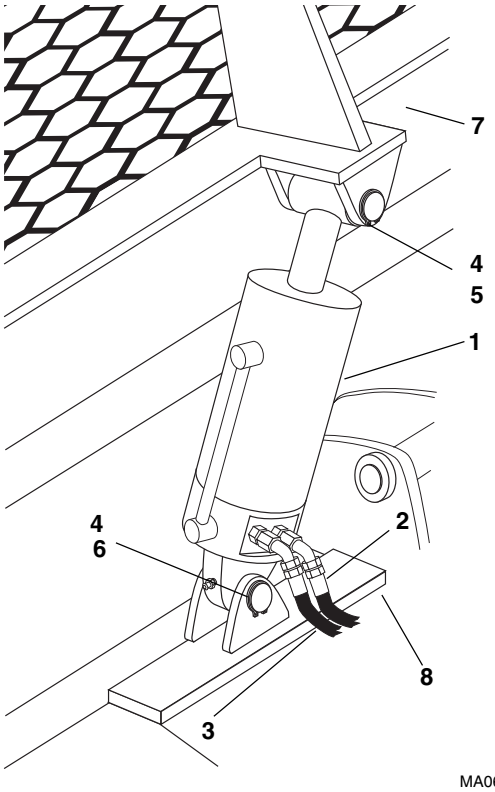
1. Remove any remaining dirt and grease from the cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. Remove check valves (2) and three O-rings (15) and backup rings (16).
4. Using a pin spanner wrench, unscrew gland (4, Fig 9.21) from the tube (1).

IMPORTANT: Protect the finish on the rod at all times. *Damage to the surface of the rod can cause premature seal failure.*

5. Pull rod (5) and attached parts straight out of the tube.

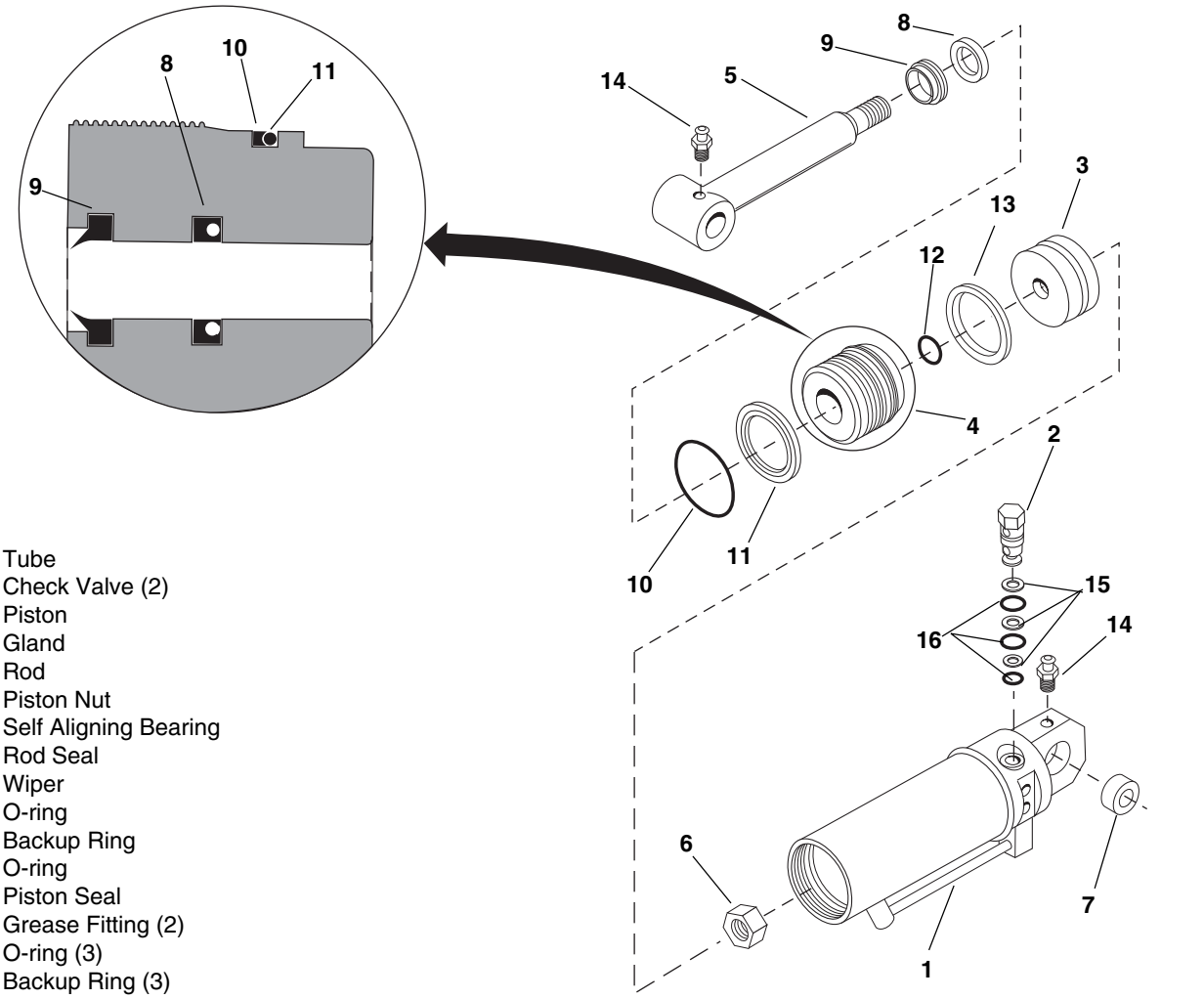
IMPORTANT: *When sliding the rod and piston assembly from the tube, be careful so that gland threads in the tube do not damage the piston. Keep the rod in line with the tube barrel to prevent binding.*

6. Fasten the eye end of the rod (5) in a soft-jawed vise and put a support below the rod near the piston to prevent damage to the rod.



1. Side Tilt Carriage Cylinder
2. Hose Assembly
3. Hose Assembly
4. Snap Ring
5. Cylinder Rod Pin
6. Cylinder Base Pin
7. Side Tilt Carriage
8. Pivot Base

Fig. 9.20 Side Tilt Carriage Cylinder Removal



1. Tube
2. Check Valve (2)
3. Piston
4. Gland
5. Rod
6. Piston Nut
7. Self Aligning Bearing
8. Rod Seal
9. Wiper
10. O-ring
11. Backup Ring
12. O-ring
13. Piston Seal
14. Grease Fitting (2)
15. O-ring (3)
16. Backup Ring (3)

Fig. 9.21 Optional Side Tilt Carriage Cylinder Exploded View

7. Remove piston seal (13) from piston (3).

***NOTE**: It may be necessary to apply heat to break the bond of the sealant between nut (6) and rod (5) before the piston can be removed. Refer to paragraph 9.2a.*

8. Remove nut (6), piston (3), and the gland (4) from the rod.
9. Remove O-ring (12) from inside of the piston.
10. Remove O-ring (10), backup ring (11), wiper (9) and rod seal (8) from the gland.
11. If necessary to replace, remove grease fittings (14).
12. If bearing (7) needs replacement, press bearing from the cylinder tube.

c. Cleaning

1. Discard <u>all</u> seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that rod (5, Fig. 9.21) is straight. If the rod is bent, install new rod.
2. Inspect the inside of tube (1) for scoring and other damage. If there is any damage to the tube, replace with new tube.
3. Remove small scratches on the piston rod or inside of the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut (6) and the bottom of piston (3) with a fine file. Clean parts with trichlorethylene after repair.

e. Assembly

***NOTE**: Follow general assembly instructions in paragraph 9.2c.*

1. If bearing (7, Fig 9.21) was removed for replacement, press new bearing into eye of tube (1). The bearing should protrude the same distance from each side of the eye.
2. Install new O-ring (10), backup ring (11), wiper (9), and rod seal (8) on gland (4) as shown in Fig. 9.21.

***NOTE:** The wiper lip should be toward the inner end of the gland and the rod seal toward the outer end of the gland. Use tools that will not damage the seal. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.*

3. Fasten the rod eye in a soft-jawed vise or other acceptable holding device. Put a padded support below and near the end of the rod to prevent damage to the rod.
4. Push the assembled gland onto the rod (5). If necessary, use a soft hammer to drive the gland onto the rod.
5. Install a new O-ring (12) on the inside of the piston. Carefully install piston (3) on the rod to avoid damage to O-ring.
6. Apply Loctite® Primer T and Threadlocker 271 to the nut (2) in accordance with the manufacturer's instructions. Install the nut on the rod and torque to 400 to 450 lb-ft (544 to 612 N m). Stake the nut in four places.
7. Install new piston seal (13) on the piston.
8. Fasten the cylinder tube (3) in a soft-jawed vise or other acceptable holding equipment. Be careful not to damage the tube.
9. Lubricate the inside of the tube, piston, and gland O-ring (9) with clean hydraulic oil.
10. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (10) on the gland. Insert the assembled piston, rod and the gland into the tube (3). Using a pin spanner wrench, thread the gland into the tube. Remove the compression tool

***IMPORTANT**: When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.*

11. Install new O-rings (15) and backup rings (16) on check valves (1). Use new valve if either valve was removed for replacement. Lubricate outside of the valves with clean filtered hydraulic oil. Install the valves and torque to 30 to 35 lb-ft (40,8 to 47,6 N m).
12. If removed, install grease fittings (14).

IMPORTANT

When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seals. Keep the rod in line with the tube barrel to prevent binding.

13. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
14. Increase the operating pressure to the maximum (1750 psi or 120 bar) for the cylinder and check for external leakage and free movement in both directions.
15. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Install the side tilt carriage cylinder (1, Fig. 9.21) on the side tilt carriage (7). Secure the rod end to side tilt carriage (7).
2. Secure the tube end to the pivot base (8) with snap rings (4).
3. Lubricate the pivot pins with multi-purpose lithium-based grease.

Warning !

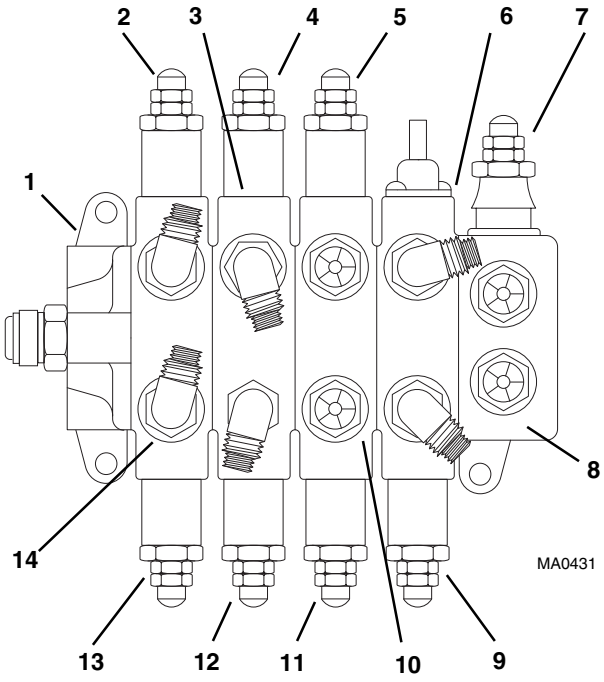
Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Remove all plugs and caps from the hydraulic lines and securely tighten the lines to the cylinder.
5. Start the forklift engine and remove blocking from the carriage.
6. Tilt the side tilt carriage five times through its full range or until the operation of the side tilt carriage is normal (no jerks or spongy feel).
7. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.

9.3 VALVES

9.3.1 Main Control Valve Assembly

The main control consists of eight relief valves, four directional control valves, and an inlet and outlet section, Fig. 9.22. For a description of how each component operates in a specific circuit refer to paragraph 9.1.



1. Outlet Section
2. Frame Tilt Right Relief Valve (1200 ± 50 psi or 82,7 ± 3,4 bar setting)
3. Grille Tilt Control Valve
4. Grille Tilt Up Relief Valve (2650 ± 50 psi or 182,6 ± 3,4 bar setting)
5. Boom Extend Relief Valve (2650 ± 50 psi or 182,6 ± 3,4 bar setting)
6. Boom Hoist Control Valve
7. Main Relief Valve (3000 ± 50 psi or 206,7 ± 3,4 bar setting)
8. Inlet Section
9. Boom Hoist Relief Valve (2650 ± 50 psi or 182,6 ± 3,4 bar setting)
10. Boom Extend/Retract Control Valve
11. Boom Retract Relief Valve (2650 ± 50 psi or 182,6 ± 3,4 bar setting)
12. Grille Tilt Down Relief Valve (2650 ± 50 psi or 182,6 ± 3,4 bar setting)
13. Frame Tilt Left Relief Valve (1200 ± 50 psi or 82,7 ± 3,4 bar setting)
14. Frame Tilt Control Valve

Figure 9.22 Main Control Valve Components

a. Main Control Valve Removal

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate all of the hydraulic functions (boom raise/lower, extend/retract, grille tilt and frame tilt) after the engine has stopped to relieve any trapped pressure.
3. Remove the transmission cover.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

4. Remove dirt and grease from the hydraulic lines and fittings, on main control valve (6, Fig. 9.23) and nearby components.
5. Tag and disconnect the hydraulic lines from the main control valve and cap or plug the connectors.
6. Tag and disconnect control linkage (7) from main control valve by removing cotter pins (1) and retaining pins (2).
7. Remove the capscrews (5), locknuts (3), and washer (4) securing the control valve to the frame.
8. Remove the main control valve from the forklift.
9. Remove any remaining dirt and grease from the valve assembly.

b. Relief Valve Repair

Operation

Fluid at supply pressure is admitted to the relief area, Fig. 9.24, of the valve through a hole in the piston. Initially, the pilot poppet, relief valve poppet and check valve poppet are seated.

1. Cotter Pin
2. Retaining Pin
3. Locknut
4. Washer
5. Capscrew
6. Main Control Valve
7. Linkage

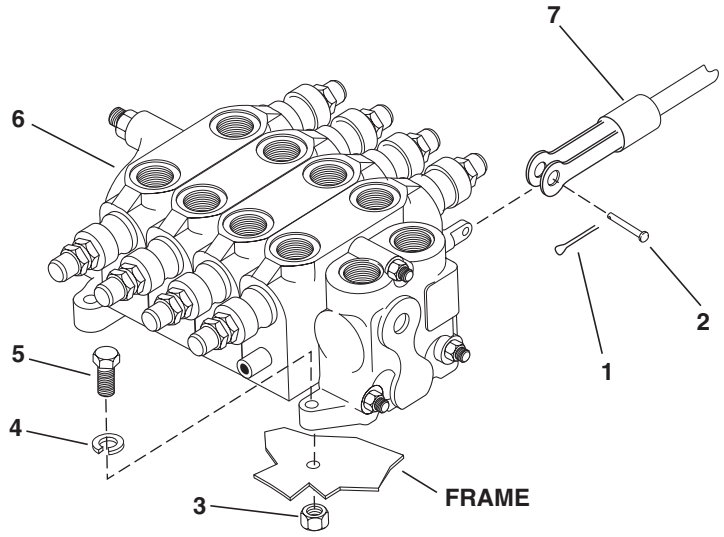


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Fig. 9.23 Main Control Valve Installation

The relief valve setting is determined by the compression of the pilot spring as set by the adjustment screw. When the pressure exceeds the relief setting, the pilot poppet acts against the poppet spring to unseat. The fluid then flows around the pilot poppet through cross-drilled holes in the plug to the reservoir; some pressure is relieved.

Due to the reduced pressure, the piston seats against the pilot poppet. This shuts off fluid flow through the valve and causes a low pressure area internally. The differential pressure between the supply pressure and the internal pressure causes the relief valve poppet to unseat and fluid flows to the reservoir thus relieving the pressure.

If low supply pressure should occur due to pump cavitation, the check valve poppet will unseat and allow fluid to flow back to the supply from the reservoir.

Refer to paragraph 9.1 for information on relief valve functions and testing.

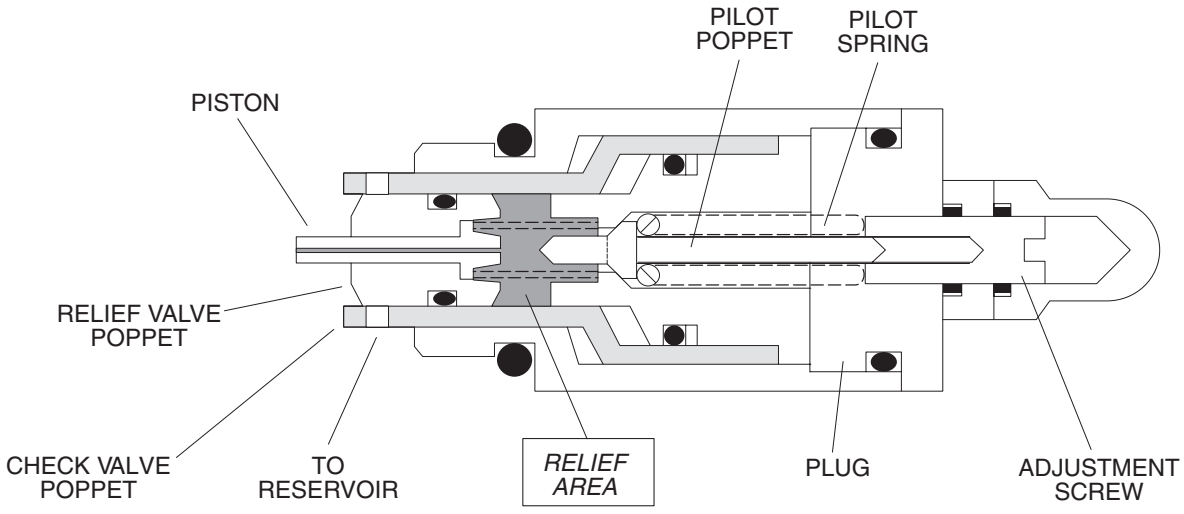

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Fig. 9.24 Relief Valve Sectional View

Disassembly

1. Remove the relief valve from the control valve housing.
2. Unscrew plug (1, Fig. 9.25) and remove the relief valve cartridge from housing (8).
3. Remove and discard O-ring (9) from housing.
4. Remove acorn nut (19) and jam nut (17) from adjustment screw (15).
5. Remove and discard O-rings (16 and 18).
6. Unscrew adjustment screw (15) from plug (1).
7. Invert the plug. Pilot spring (14) and poppet (13) should drop out.
8. Remove O-rings (10 and 12) and backup ring (11) from the plug.
9. Remove piston spring (2), piston (3) and relief valve poppet (4) from check valve poppet (7).
10. Remove and discard O-ring (5) and backup ring (6) from the relief valve poppet.

Cleaning and Drying

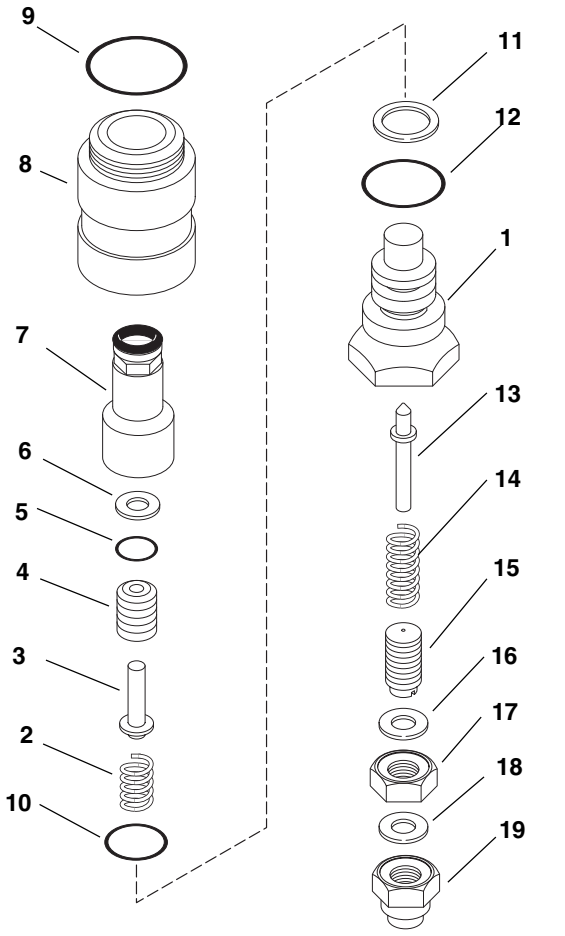
Clean metal parts in an approved solvent such as trichlorethylene and blow dry.

Inspection and Replacement

1. Inspect the poppet seating surfaces. They must be sharp, clean, and free of nicks or excessive wear. Replace the part if worn or damaged.
2. Install new O-rings and backup rings. Repair kits are available.
3. Clean out the channel in piston (3, Fig. 9.25) through which fluid passes.
4. Make sure the piston moves freely in the relief valve poppet.

Assembly

1. Lubricate with hydraulic oil and install new O-ring (5, Fig. 9.25) and backup ring (6) on relief valve poppet (4). Stretch O-ring, do not roll it to fit.
2. Lubricate poppet (4) with hydraulic oil and insert into check valve poppet (7) followed by piston (3) and piston spring (2).
3. Lubricate with hydraulic oil and install new O-ring (10), backup ring (11) and O-ring (12) on plug (1). Stretch O-rings, do not roll them to fit.
4. Lubricate exterior of plug (1) and insert into poppet (7).



1. Plug
2. Pilot Spring
3. Piston
4. Relief Valve Poppet
5. O-ring
6. Backup Ring
7. Check Valve Poppet
8. Housing
9. O-ring
10. O-ring
11. Backup Ring
12. O-ring
13. Pilot Poppet
14. Pilot Spring
15. Adjustment Screw
16. O-ring
17. Jam Nut
18. O-ring
19. Acorn Nut

Fig. 9.25 Relief Valve Exploded View

5. Insert pilot poppet (13) and spring (14) into the plug.
6. Install adjustment screw (15) into the plug.
7. Lubricate and install new O-rings (16 and 18) on nuts (17 and 19). Stretch O-rings, do not roll them to fit.
8. Install jam nut (17) and acorn nut (19) on the adjustment screw. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13,5 ± 2 N m).
9. Install the relief valve cartridge in the housing. The cartridge is a honed fit and may require gentle tapping to install.

IMPORTANT: *Care must be taken to avoid damaging the valve's internal lands.*

10. Lubricate and install new O-ring (9) on housing (8). Stretch O-ring, do not roll it to fit.
11. Install assembled relief valve in the control valve housing. Torque all relief valves except main relief valve to 40 ± 4 lb-ft (55 ± 5,5 N m). Torque main relief valve to 60 to 80 lb-ft (82 to 109 N m).
12. Adjust relief valve pressure as instructed in paragraph 9.1.

c. Repair of Main Control Valve

Disassembly

To replace seals between the sections of the main control valve:

1. Remove nuts (1 and 13, Fig. 9.26) at outlet section (8).
2. Remove outlet section carefully to avoid losing spring (11).
3. Remove O-ring (3) and discard.
4. Remove spring (11) and check valve poppet (12) from frame tilt section (7).
5. Repeat steps 2, 3 and 4 for the remaining valve sections (6, 5, and 4).
6. Remove nuts (1 and 13) and tie rods (9 and 10) at inlet section (2).

Cleaning and Drying

Clean all metal parts in an approved solvent such as trichlorethylene and blow dry.

Assembly

1. Thread nuts (1, Fig. 9.26) onto ends of tie rods (9 and 10) until nuts are flush with the ends of the tie rods.

1. Special Nuts (4)
2. Inlet Section
3. O-rings (5)
4. Boom Hoist Section
5. Boom Extend Section
6. Grille Tilt Section
7. Frame Tilt Section
8. Outlet Section
9. Tie Rods (2)
10. Tie Rod
11. Spring
12. Check Valve Poppet
13. Special Nuts (2)

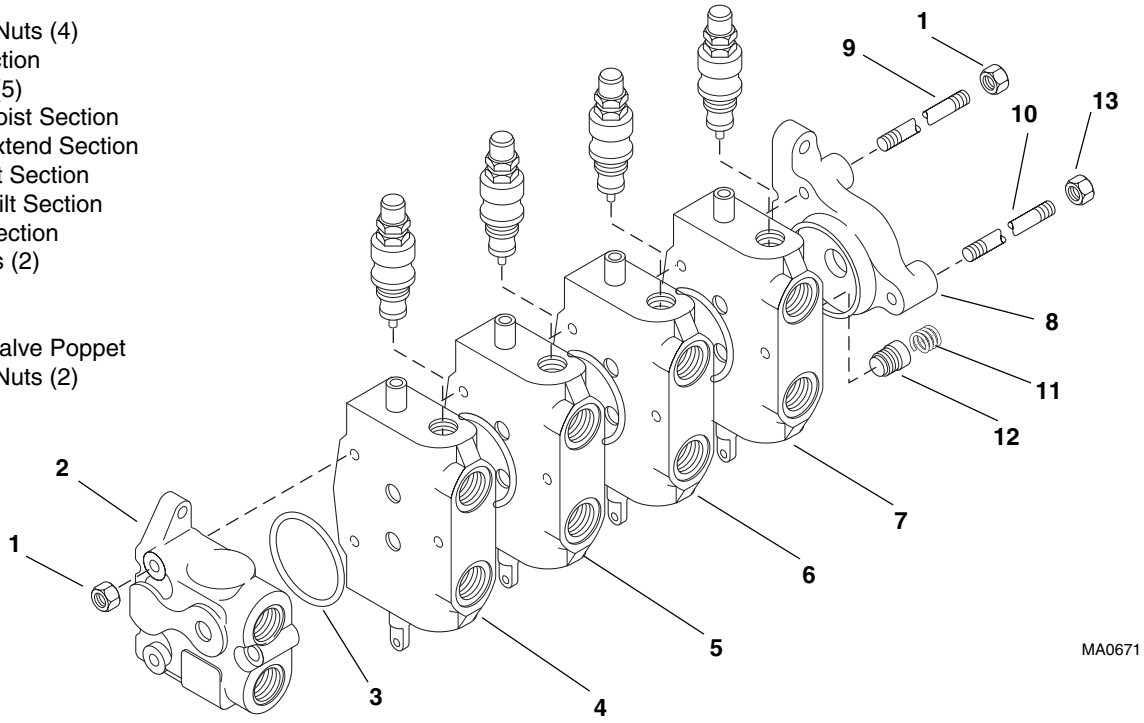


Fig. 9.26 Main Control Valve Sections

2. Install new O-ring (3) in inlet section (2).
3. Install tie rods (9 and 10) from the outside of inlet section (2) through the holes in the inlet section.
4. Install boom hoist section (4) over tie rods (9 and 10)
5. Repeat steps 2 thru 4 for the remaining valve sections (5 thru 8).
6. Install check valve poppet (12) and spring (11) into frame tilt section.
7. Install nuts (1 and 13) on the ends of the tie rods (9 and 10) and tighten the nuts so the rods protrude the same amount from both sides of the valve. Torque nuts (1) to 48 ± 4.8 lb-ft (65 ± 6,5 N m). Torque nuts (13) to 75 ± 7.5 lb-ft (102 ± 10 N m).

d. Repair of Main Control Valve Sections

When repairing the main control valve, first refer to paragraph b and repair the relief valveds. It might be advisable to install seal and spring (repair) kits in all of the relief valves at this time.

Disassembly

1. Remove two socket head capscrews (1, Fig. 9.27) and spool cap (2).
2. Remove spool end (3), spring seat (4), spring (5), spring end (4), wiper (6) and O-ring (7).
3. Remove two round head machine screws (10), seal plate (9), wiper (6), and O-ring (7).

Cleaning and Drying

Clean all metal parts in an approved solvent such as trichlorethylene and blow dry.

Inspection and Replacement

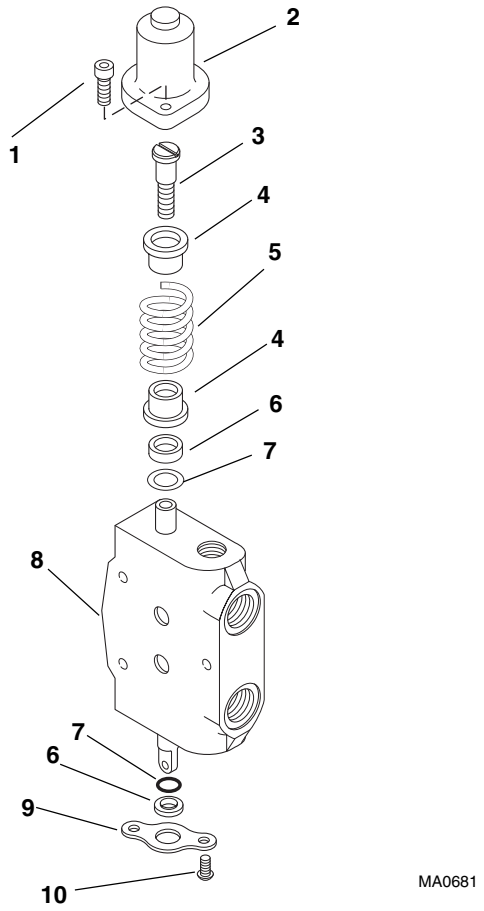
1. Inspect spool seating surfaces. They must be sharp, clean, and free of nicks or excessive wear. Replace entire section if worn or damaged.
2. Replace all O-rings and backup rings with new ones. Repair kits are available.
3. Make sure the piston moves freely in valve section.

Assembly

1. Insert spool in the linkage end of the section.

IMPORTANT*. Take care during insertion to avoid damaging the valve's internal lands.*

2. Install O-ring (7, Fig. 9.27), wiper (6) and seal plate (9) and secure with two round head screws (10).



1. Hex Socket Capscrew (2)
2. Spool Cap
3. Spool End
4. Spring Seat
5. Spring
6. Wiper
7. O-ring
8. Section Body with Spool (body and spool supplied only as a complete assembly)
9. Seal Plate
10. Round Head Screw (2)

Figure 9.27 Valve Section Exploded View

3. Install O-ring (7), spool end (3), spool cap (2) and secure with socket head capscrews (1).

e. Main Control Valve Installation

1. Position the main control valve (6, Fig. 9.23) on the forklift and secure it to frame using capscrews (5), locknuts (3), and washers (4).
2. Install control linkage (7) using retaining pins (2) and cotter pins (1).
3. Connect hydraulic lines to control valve.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Start the forklift engine.
5. Inspect connections at the control valve for leakage.
6. Operate joysticks to test the operation of the control valve and hydraulic system. Refer to paragraph 9.1 for instructions on adjustment of relief valve settings
7. Install the transmission cover.

9.3.2 Brake Valve

a. Removal

1. Retract the boom and support it in a horizontal and level position.
2. Engage the park lock, place the travel select lever in neutral, and stop the engine.

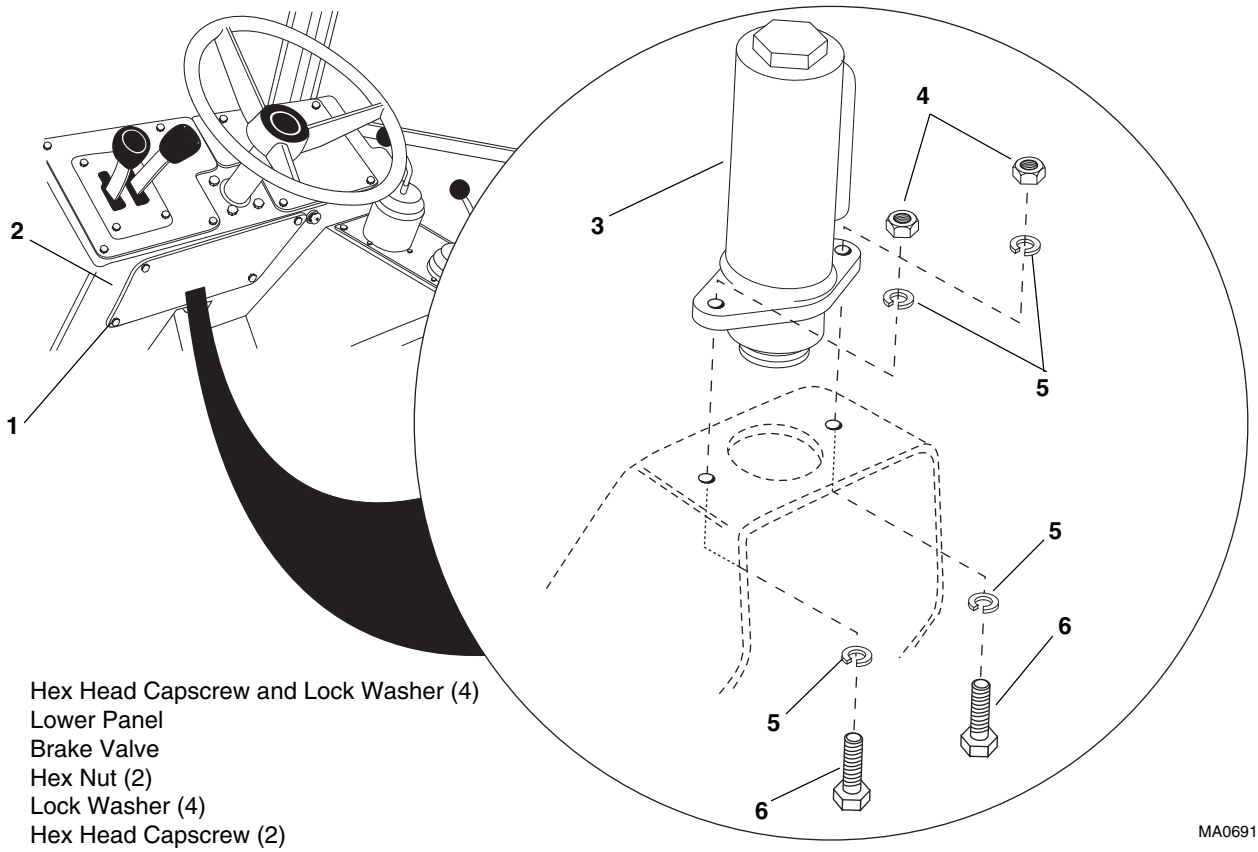
Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

3. Operate the brake pedal after the engine has stopped to relieve any trapped pressure.
4. To gain access to brake valve (3, Fig. 9.28), remove four hex head screws and lock washers (1), to detach the lower panel (2) which is located under the dash.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.



1. Hex Head Capscrew and Lock Washer (4)
2. Lower Panel
3. Brake Valve
4. Hex Nut (2)
5. Lock Washer (4)
6. Hex Head Capscrew (2)

Fig. 9.28 Brake Valve Installation

5. Tag and disconnect three hydraulic hoses (4, Fig. 9.30) from the right side of the service brake valve. Cap and plug the open hose connectors.
6. Remove jam nuts (4, Fig. 9.28), lock washers (5) and capscrews (6) which secure valve to the mounting bracket.
7. Remove the service brake valve from the machine.

b. Disassembly

1. Remove ring (1, Fig. 9.29) and boot (2) from housing (13).
2. Remove piston (3), shim or shims (4), and springs (5 and 6) from housing bore.
3. Carefully remove O-ring (7) to avoid scratching the housing bore.
4. Carefully remove retaining ring (8) to avoid scratching housing bore.
5. Remove washer (9), plunger (10) and spring (12) from housing bore.
6. Remove cup (11) from plunger (10).
7. Remove plug (23) from housing (13).
8. Remove O-ring (22), cup (20) and backup ring (21) from plug (23).
9. Remove washer (19), sleeve (18), spring (17) and guide (16) from the housing bore.

NOTE: *Some valves may not have a sleeve (18).*

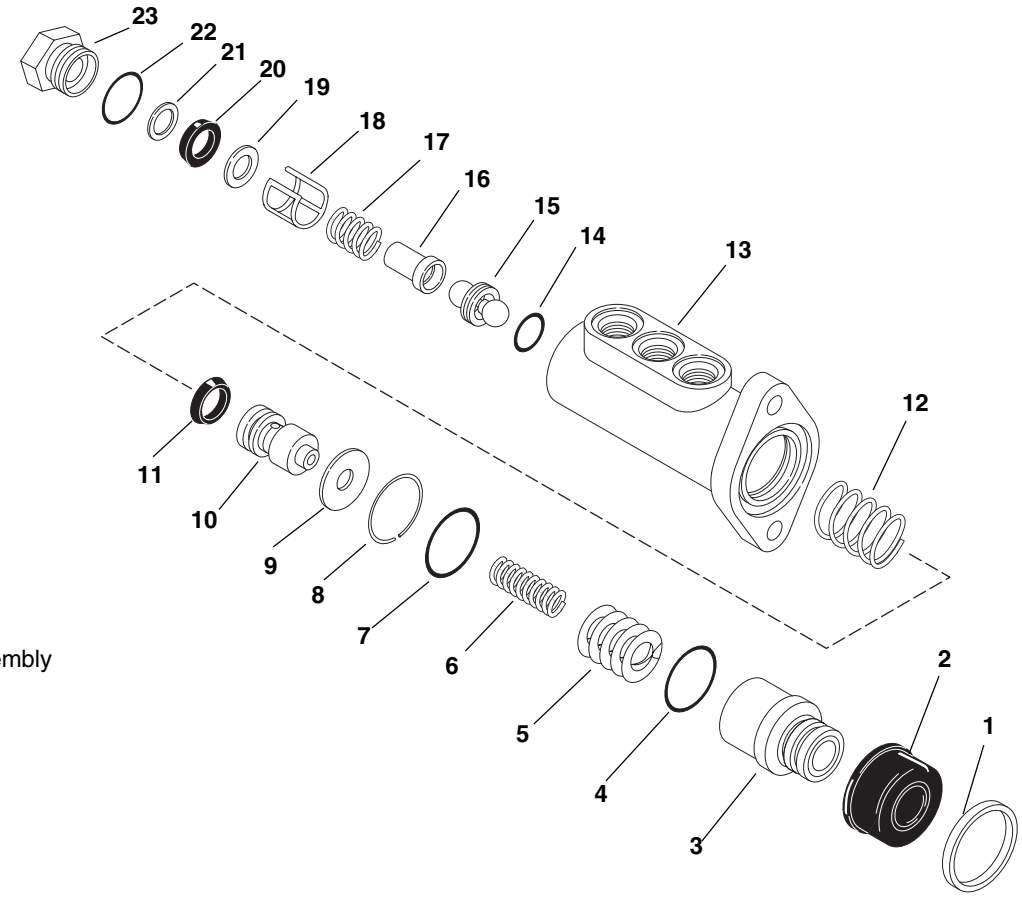
10. Remove valve and ball assembly (15) from housing bore.
11. Remove O-ring (14) from the valve and ball assembly.

c. Cleaning and Drying

Clean all metal parts in an approved cleaning solvent such as trichlorethylene and blow dry.

d. Inspection, Repair and Replacement

1. Inspect valve bore for deep grooves or other damage. If there is any damage to the bore, replace the entire brake valve.



1. Retaining Ring
2. Boot
3. Piston
4. Shims (as required)
5. Spring
6. Spring
7. O-ring
8. Retaining Ring
9. Washer
10. Plunger
11. Cup
12. Spring
13. Housing
14. O-ring
15. Valve and Ball Assembly
16. Guide
17. Spring
18. Sleeve
19. Washer
20. Cup
21. Backup Ring
22. O-ring
23. Plug

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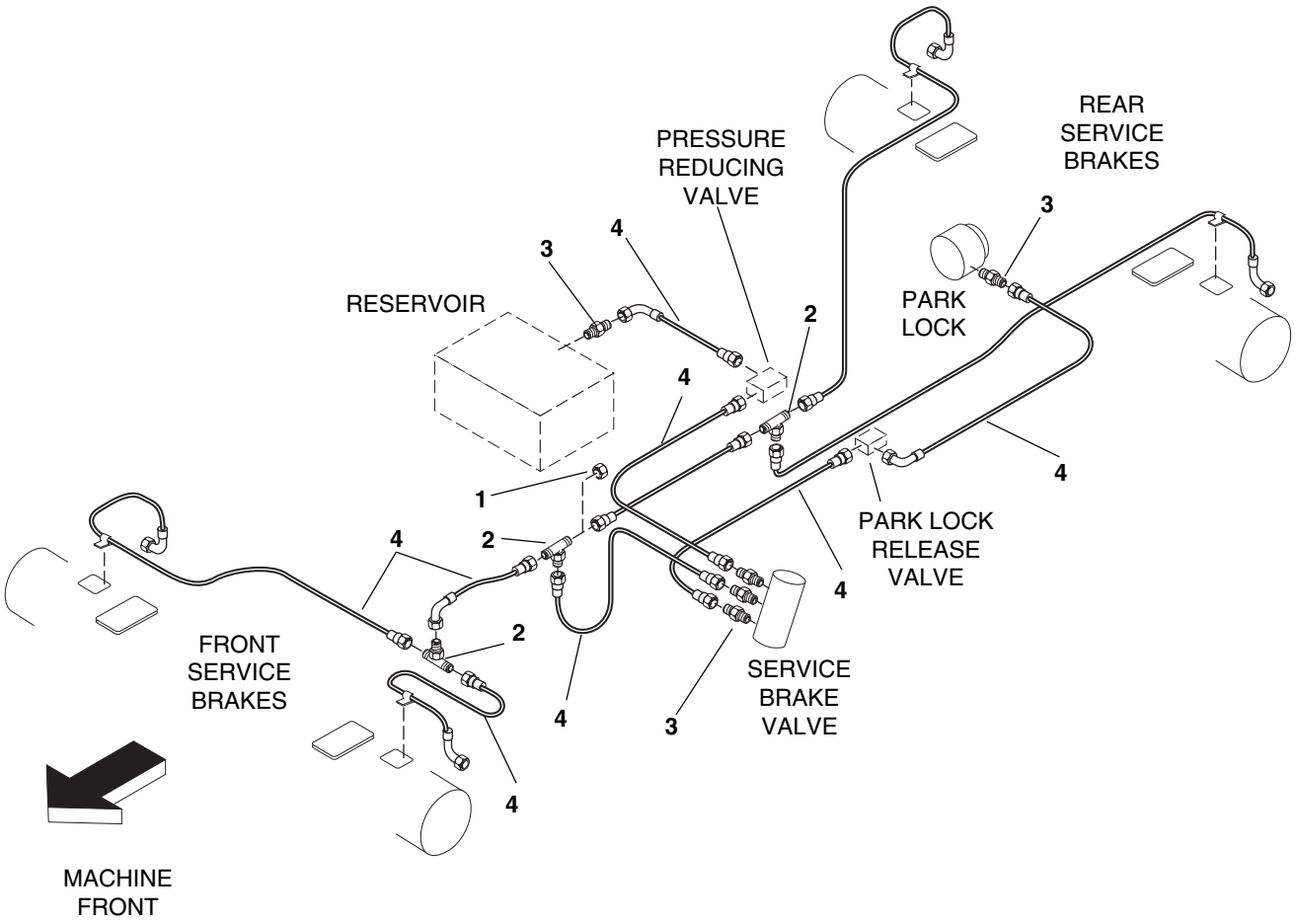
Fig. 9.29 Brake Valve Exploded View



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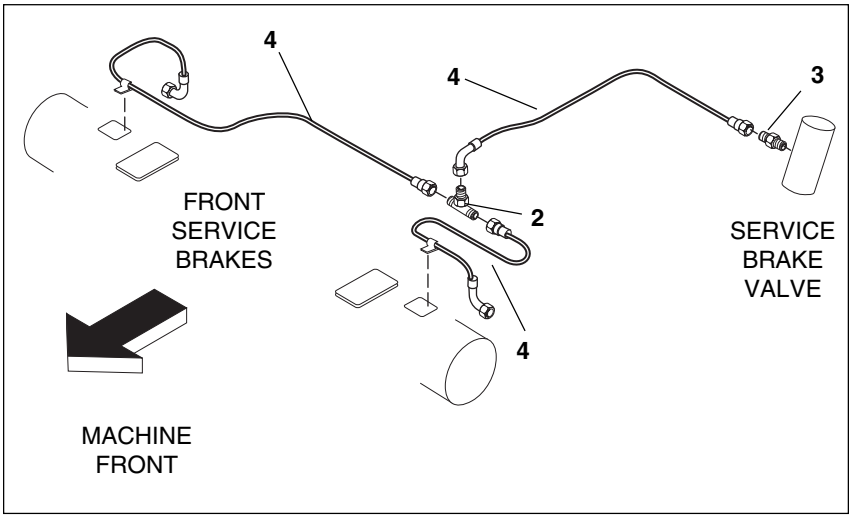

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1. Cap Used on Forklifts with Only Front Service Brakes
2. Bulkhead Tee
3. Connector
4. Hydraulic Hose

Fig. 9.30 Brake Circuits With Park Lock and Two or Four Wheel Service Brakes

2. Remove small scratches in the bore using emery cloth of very fine grit. Use the emery cloth with a rotary motion.

e. Assembly

1. Install new O-ring (14, Fig. 9.29) in the seat on valve and ball assembly (15) and insert into housing bore so that the seat end is located on the plug end of the brake valve.
2. Install guide (16), spring (17), sleeve (18) and washer (19) in the housing bore.

***NOTE**: It is desirable to install a new sleeve (18) in all units. The sleeve is part of the valve repair kit. Position the sleeve over the spring (17) and up against the seat flange.*

3. Insert new backup ring (21) and new cup (20) inside end of plug (23). Note the order of backup ring and cup.
4. Install new O-ring (22) on the plug and install in housing (13).
5. Install new cup (11) and spring (12) on plunger (10). Note that the cup lip should be facing toward the plug (pressure) end of the brake valve.
6. Insert assembled plunger into the housing bore.
7. Install washer (9) in the housing bore.
8. Carefully install retaining ring (8) in housing bore to avoid scratching the housing bore.
9. Install new O-ring (7) in housing bore.
10. Install springs (5 and 6), shim or shims (4) and piston (3) in housing bore.
11. Install boot (2) and retaining ring (1) in housing (16).

f. Valve Installation

1. Lower brake valve (9, Fig. 9.28) into position on the mounting bracket.
2. Install capscrews (6), lock washers (5) and jam nuts (4) to secure valve.
3. Remove plugs or caps as required and connect the tagged hydraulic lines to the brake valve.
4. Install lower panel (2) with capscrews and lock washers (1) after bleeding and checking brake system.

g. Bleeding the Brake Lines

Bleed the brake lines very carefully as soon as the brake valve is installed in the machine. Air in the system will not allow the brakes to release properly and may severely damage them. Bleed the brakes whenever there is reason to suspect that air has entered the braking system.

1. Place the transmission in neutral, start the engine and engage parking brake.
2. Install one end of an 18 to 24 inch (457 to 610 mm) length of transparent 1/4 inch (6 mm) inside diameter tubing over the brake bleeder, Fig. 9.31. Place the other end of this tubing in a suitable transparent container which is partially filled with hydraulic oil. The end of the tubing must be below the oil level in the container.

Warning !

The pressure at the brakes is 525 ± 25 psi (36,2 ±1,7 bar). Do not open the bleeder without holding tubing on the bleeder to prevent releasing a jet of oil that could cause personal injury.

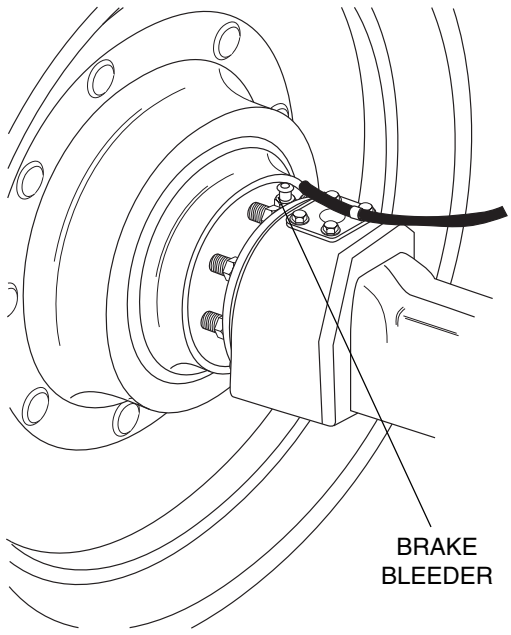


Fig. 9.31 Brake Bleeder

3. While holding the tubing firmly on the bleeder, open the bleeder with a suitable small wrench. Have an assistant depress the brake pedal. Close the bleeder when air bubbles no longer appear in the oil. Release the brake pedal and remove the tubing from the bleeder.
4. Repeat steps 2 and 3 for the brakes on the other wheels.
5. Discard the oil which was collected in the container.
6. Check level in reservoir and fill as described in the Owners/Operators Manual.

9.3.3 Park Lock Release Valve

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Depress the brake pedal to relieve any trapped pressure.
3. Remove the electrical connector from solenoid on the park lock release valve (2, Fig. 9.33).
4. Remove the solenoid, Fig. 9.32. To check the solenoid, apply 12 Vdc momentarily to the solenoid leads and check for spool movement. If solenoid does not actuate, it is defective. Refer to Section 10 for additional electrical test information.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

5. Tag and disconnect the hydraulic hoses at connector (8, Fig. 9.33) and run tee (9) and tube assembly (16) from connector (7) on the park lock release valve.
6. Remove two hex nuts (27), lock washers (25), flat washers (26) and capscrews (24).

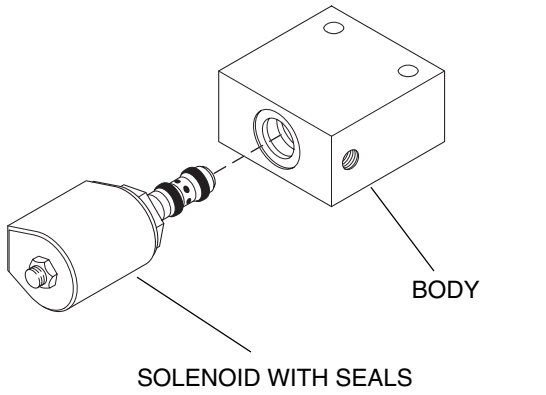


Fig. 9.32 Park Lock Release Valve

7. Lower park lock release valve (2) from valve mounting plate (30).
8. Remove hydraulic fittings from valve as required.

b. Disassembly

NOTE: *There are no serviceable parts in the park lock release valve.*

Replace solenoid (Fig. 9.32) if faulty.

c. Cleaning and Drying

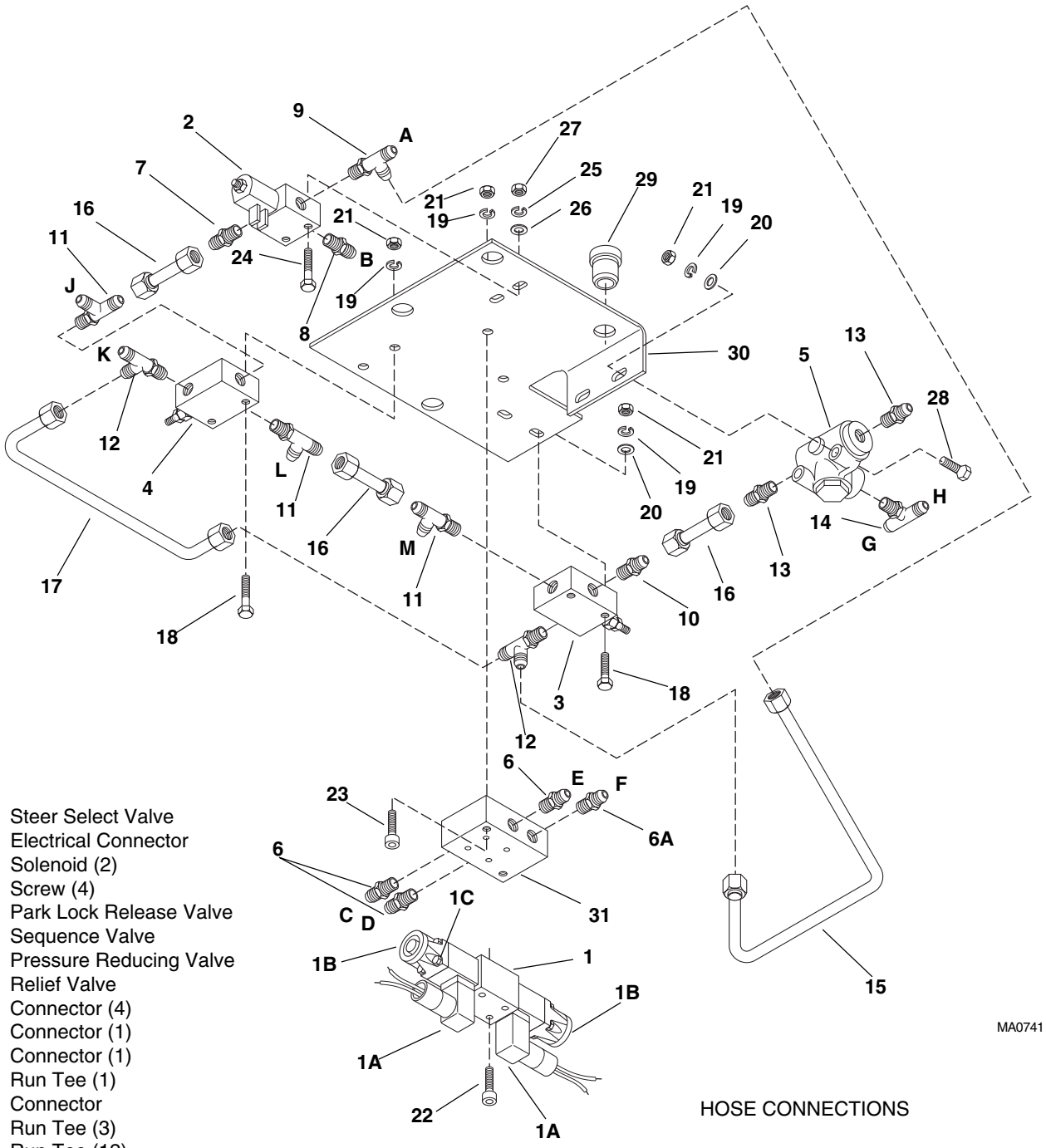
Without submerging the electrical portion of the park lock release valve (2, Fig. 9.33), clean valve in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect and replace solenoid, electrical connector and/or wiring if damaged. Use new seals on solenoid.
2. Discard entire park lock release valve if damaged.

e. Installation

1. Install connectors (7 and 8, Fig. 9.33) and run tee (9) in park lock release valve (2).
2. Position the assembled park lock release valve on valve mounting plate (30).
3. Secure valve to plate using two capscrews (24), flat washers (26), lock washers (25), and hex nuts (27).
4. Install tube assembly (16).
5. Connect hydraulic hoses to connector (8) and run tee (9).
6. Attach electrical connector to solenoid on valve (2).
7. Bleed brake circuit as described in paragraph 9.3.2.g.



1. Steer Select Valve
1A. Electrical Connector
1B. Solenoid (2)
1C. Screw (4)
2. Park Lock Release Valve
3. Sequence Valve
4. Pressure Reducing Valve
5. Relief Valve
6. Connector (4)
7. Connector (1)
8. Connector (1)
9. Run Tee (1)
10. Connector
11. Run Tee (3)
12. Run Tee (12)
13. Connector (2)
14. Branch Tee
15. Tube Assembly
16. Tube Assembly (3)
17. Tube Assembly
18. Capscrew (2)
19. Lock Washer (8)
20. Flat Washer
21. Hex Nut (8)
22. Capscrew (4)
23. Capscrew (2)
24. Capscrew (2)
25. Lock Washer (2)
26. Flat Washer (2)
27. Hex Nut (2)
28. Capscrew (2)
29. Rubber Mount (4)
30. Mounting Plate
31. Subplate

HOSE CONNECTIONS

A. To Brake Valve Return
B. To Park Lock
C. To Rear Brake Cylinder
D. To Rear Brake Cylinder
E. To Steering Unit
F. To Front Steering Cylinder
G. To Control Valve
H. To Steering Unit Outlet
I. To Steering Unit Inlet
J. To Brake Valve Inlet
K. To Reservoir
L. To Small Pump Inlet
M. To Emergency Pump Outlet

Fig. 9.33 Valve Plate Assembly - Underside View, Exploded S/N 8G0236 and After

9.3.4 Steer Select Valve

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Slowly loosen fittings at steer select valve as required (1, Fig. 9.33) to relieve any trapped pressure.
3. Remove the electrical connectors (1A) from the solenoids (1B) on steer select valve (1).

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

4. To check a solenoid, apply 12 Vdc momentarily to the solenoid leads and listen for an audible click that indicates spool movement. If there is no sound, the solenoid is probably defective. Refer to Section 10 for additional electrical test of the steer select valve.

NOTE: *If no service is required for valve subplate (31, Fig. 9.33), proceed to step 5.*

5. Tag and disconnect hydraulic hoses from connectors (6) on valve subplate (31).
6. Remove two nuts (21), lock washers (19) and capscrews (23) and remove assembled valve (1) and subplate (31).
7. Remove connectors (6) from the subplate.
8. Remove steer select valve (1) from the subplate by removing four capscrews (22).
9. Remove and discard O-rings between subplate and steer select valve.

b. Disassembly

NOTE*: There are no serviceable parts in the steer select valve; do not disassemble.*

Replace solenoid(s) if defective. Remove four screws (1C) to detach each solenoid.

c. Cleaning

Without submerging the electrical portion of the steer select valve, clean valve in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect solenoids, electrical connectors and wiring and replace if damaged.
2. Replace entire steer select valve if damaged.

e. Installation

1. Install four new O-rings in base ports of steer select valve (1, Fig. 9.33).
2. Position the steer select valve on valve subplate (31) and secure with four capscrews (22).

NOTE*: If the valve subplate was removed for service, continue with steps 3 through 5.*

3. Install connectors (6) in the subplate.
4. Place the assembled steer select valve and valve subplate on mounting plate (30). Install two capscrews (23), lock washers (19) and nuts (21) to secure.
5. Connect hydraulic hoses to connectors (6).
6. Install electrical connectors.

f. Bleeding Steering System

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

1. Start the forklift engine and run at idle.
2. Turn the steering wheel fully left to right and back (lock to lock) several times in all three steering modes until they operate smoothly. This should purge the steering system of air.
3. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.

9.3.5 Sequence Valve

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Slowly loosen the fittings at the sequence valve (3, Fig. 9.33) as required to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Tag and disconnect tube assemblies (15, 16 and 17) from connector (10) and run tees (11 and 12) on the sequence valve (3).
4. Tag and disconnect hydraulic hose from run tee (11).
5. Remove two hex nuts (21), lock washers (19), flat washers (20) and capscrews (18). Remove sequence valve (3) from valve mounting plate (30).
6. Remove hydraulic fittings from the valve as required.

b. Disassembly

***NOTE**: There are no serviceable parts in the steer sequence valve; do not disassemble.*

Remove sequence valve cartridge (Fig. 9.34).

c. Cleaning

Clean metal parts of valve with an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect valve cartridge (Fig. 9.34) for wear, scoring, damaged seals and other damage. Replace cartridge if damaged.
2. Discard entire sequence valve if damaged.

e. Installation

1. Install connector (10, Fig. 9.33) and run tees (11 and 12) on sequence valve (3).
2. Position the sequence valve on valve mounting plate (30) and secure with two capscrews (18), flat washers (20), lock washers (19) and hex nuts (21).
3. Connect hydraulic tube assemblies (15, 16 and 17) to connector (10) and run tees (11 and 12).
4. Connect hydraulic hose to run tee (11).
5. Check the hydraulic oil level and fill as described in the Owners/Operators Manual.

9.3.6 Steer Relief Valve

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

2. Tag and disconnect hydraulic hoses from branch tee (14, Fig. 9.33) and connector (13).

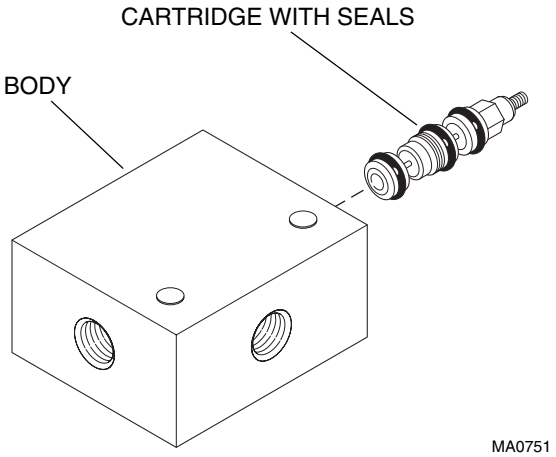


Fig. 9.34 Valve Cartridge for Sequence, Pressure Reducing and Counterbalance Valves

3. Tag and disconnect tube assembly (16) from connector (13).
4. Remove two hex nuts (21), lock washers (19), flat washers (20) and socket head capscrews (28) to detach the relief valve.
5. Remove hydraulic fittings from valve as required.

b. Disassembly

NOTE: *There are no serviceable parts in the relief valve; do not disassemble.*

Remove steering relief valve cartridge (Fig. 9.35).

c. Cleaning

Clean metal parts of valve in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect valve cartridge (Fig. 9.35) for wear, scoring, damaged seals and other damage. Replace cartridge if damaged.
2. Discard entire steer relief valve if damaged.

e. Installation

1. Install connector (13, Fig. 9.33) and branch tee (14) on relief valve (5).
2. Position the relief valve on valve mounting plate (30) and secure with two capscrews (28), flat washers (20), lock washers (19) and hex nuts (21).
3. Connect tube assembly (16) to connector (13).
4. Connect hydraulic hoses to branch tee (14) and connector (13).

f. Bleeding Steering System

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

1. Start the forklift engine and run at idle.
2. Turn the steering wheel fully left to right and back (lock to lock) several times in all three steering modes until they operate smoothly. This should purge the steering system of air.
3. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.

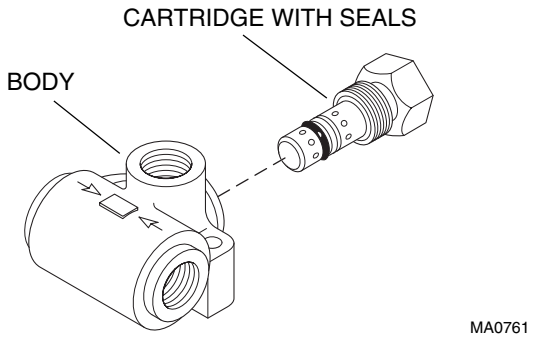


Fig. 9.35 Valve Cartridge for Pressure Relief Valve

9.3.7 Pressure Reducing Valve

a. Removal

NOTE: *On forklifts with S/N 8F0235 and before, refer to paragraph 9.3.8 and remove counterbalance valve before you begin.*

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Slowly loosen the fittings at the pressure reducing valve as required to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Tag and disconnect hydraulic hoses and tube assemblies (16 and 17, Fig. 9.33) from run tees (11 and 12) on pressure reducing valve (4).
4. Remove two hex nuts (21), lock washers (19) and capscrews (18) to detach pressure reducing valve (4) from valve mounting plate (30).
5. Remove hydraulic fittings from valve as required.

b. Disassembly

***NOTE**: There are no serviceable parts in the pressure reducing valve; do not disassemble.*

Remove pressure reducing valve cartridge (Fig. 9.34).

c. Cleaning

Clean metal parts of valve in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect valve cartridge (Fig. 9.34) for wear, scoring, damaged seals and other damage. Replace cartridge if damaged.
2. Discard entire pressure reducing valve if damaged.

e. Installation

1. Install run tees (11 and 12, Fig. 9.33) in pressure reducing valve (4).
2. Position the pressure reducing valve on valve mounting plate (30) and secure with two capscrews (18), lock washers (19) and hex nuts (21).
3. Connect tube assemblies (16 and 17) and hydraulic hoses to run tees (11 and 12) on the pressure reducing valve.
4. Refer to paragraph 9.3.8 for installation of the counterbalance valve.
5. Bleed brake circuit as described in paragraph 9.3.2g.

9.3.8 Counterbalance Valve (S/N 8F0235 and before only)

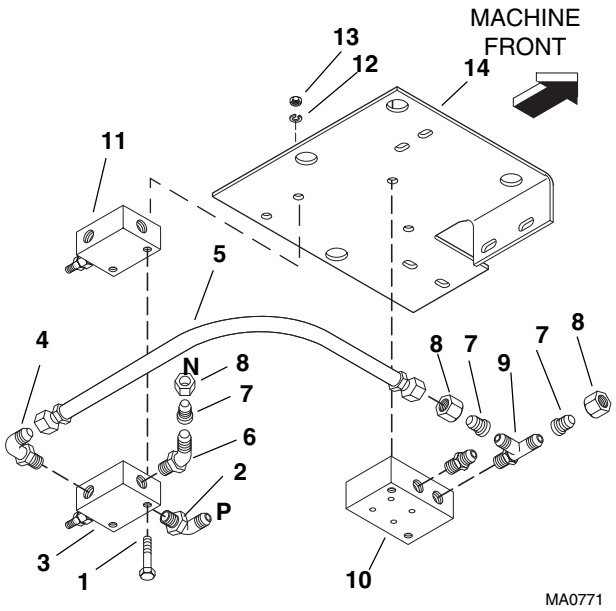
a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Slowly loosen the fittings at the counterbalance valve (3, Fig. 9.36) to relieve any trapped pressure.



1. Capscrew
2. Elbow
3. Counterbalance Valve
4. Elbow
5. Hose
6. Elbow
7. Reducer (3)
8. Nut (3)
9. Run Tee
10. Steer Select Valve Subplate
11. Pressure Reducing Valve
12. Lock Washer (2)
13. Hex Nut (2)
14. Valve Plate

HOSE CONNECTIONS

N. To front steering unit
P. To steering unit

Fig. 9.36 Counterbalance Valve Installation

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Tag and disconnect hydraulic hoses to elbows (6, Fig. 9.36) in counterbalance valve (3).
4. Remove two hex nuts (13), lock washers (12) and capscrews (1) to detach the counterbalance valve and pressure reducing valve (11) from valve mounting plate (14).
5. Refer to paragraph 9.3.7 for maintenance information for the pressure reducing valve.
6. Remove hydraulic fittings from valve as required.

b. Disassembly

***NOTE: T**here are no serviceable parts in the counterbalance valve; do not disassemble.*

Remove the counterbalance valve cartridge, Fig. 9.34.

c. Cleaning

Clean metal parts of valve in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect valve cartridge (Fig. 9.34) for wear, scoring, damaged seals and other damage. Replace cartridge if damaged.
2. Discard entire counterbalance valve if damaged.

e. Installation

***NOTE:** Be sure that all tube and hose connections to the pressure reducing valve have been made. Refer to paragraph 9.3.7.*

1. Install elbows (6, Fig. 9.36), reducers (7) and tube nuts (8).
2. Position counterbalance valve (3) under pressure reducing valve (11) and secure to mounting plate (14) with two capscrews (1), lock washers (12) and hex nuts (13).
3. Connect hydraulic hoses to elbows (6).

f. Bleeding Steering System

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

1. Start the forklift engine and run at idle.
2. Turn the steering wheel fully left to right and back (lock to lock) several times in all three steering modes until they operate smoothly. This should purge the steering system of air.
3. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operator's Manual.

9.4 PUMPS

9.4.1 Main Tandem Pump

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic joystick to relieve any trapped pressure in the 30 gpm section of the tandem pump. Slowly loosen the upper outlet port fitting on the 15 gpm pump section to relieve any trapped pressure.

Warning !

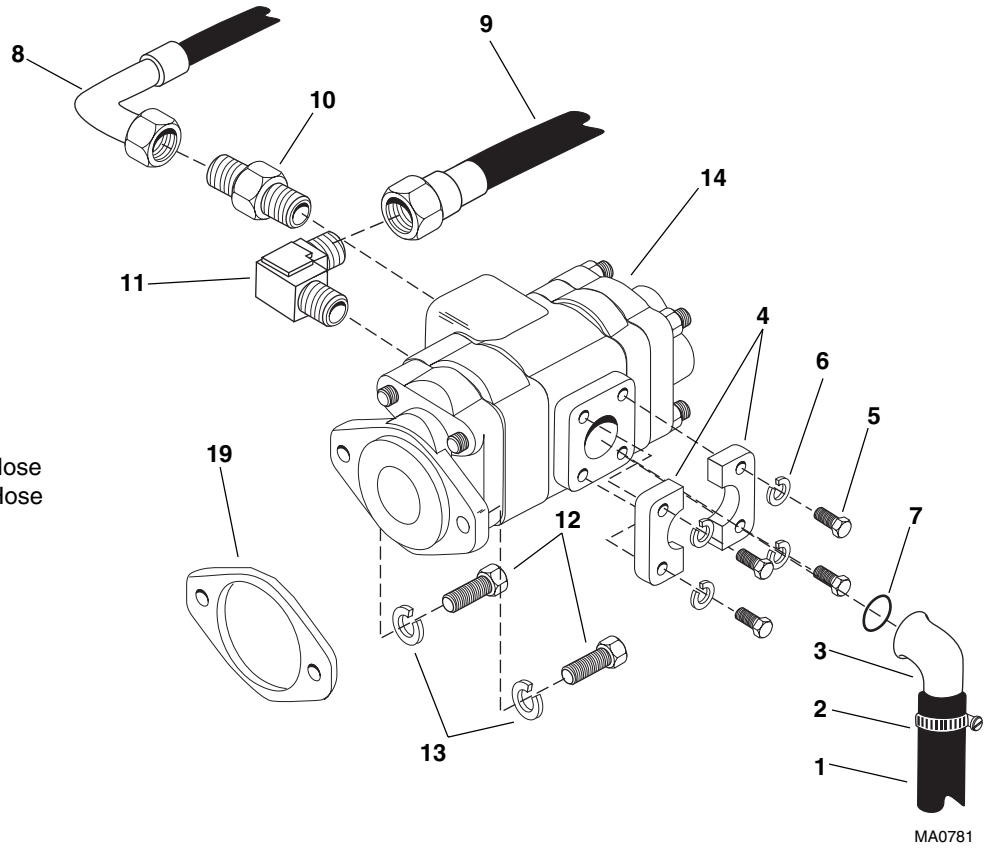
Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove hex head capscrews (5), lock washers (6), and both clamp halves (4) on the main pump inlet line. Disconnect the hose elbow (3) from the pump inlet. Remove and discard the O-ring (7) from the elbow.
4. Disconnect small pump outlet hose (8).
5. Disconnect large pump outlet hose (9).
6. Remove connector (10) and elbow (11) from the pump outlets.
7. Remove capscrews (12) and lock washers (13) that attach the main tandem pump (14) to the transmission. Remove and discard the pump gasket (15).

b. Tools Required for Pump Repair

The following tools are required for tandem pump disassembly and assembly:

1. A bushing puller made from Collet 33863 of Blind Hole Puller Set 981 by Owatonna Tool Company or an equivalent puller from another supplier. Modify this collet as shown in Fig. 9.38.



1. Hose Clamp
2. Inlet Hose
3. Elbow
4. Clamp Half (2)
5. Capscrew (4)
6. Lock Washer (4)
7. O-ring
8. Small Pump Outlet Hose
9. Large Pump Outlet Hose
10. Connector
11. Elbow
12. Capscrew (2)
13. Lock Washer (2)
14. Main Tandem Pump
15. Pump Gasket

Fig. 9.37 Main Tandem Pump Installation

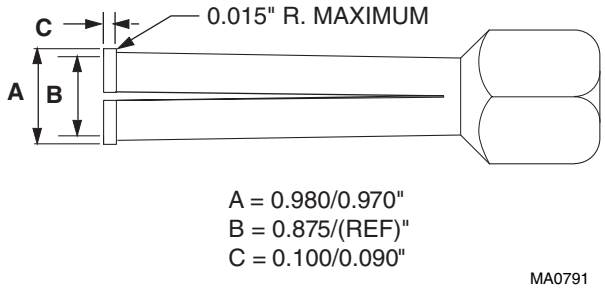


Fig. 9.38 Bushing Puller

2. A seal removal tool made by heating the tip of an old screwdriver and bending it as shown in Fig. 9.39. Grind off the tip to fit the notch behind the shaft seal.
3. A bushing installation tool made from A.I.S.I. 8620 Heat Treated Bearing Quality Steel as shown in Fig. 9.40.
4. A special steel sleeve made from bar stock which is 1-1/8 or 1-1/4" diameter by 4-5/8", as shown in Fig. 9.41. This sleeve is used to insert the drive shaft through the lip seal without damage.

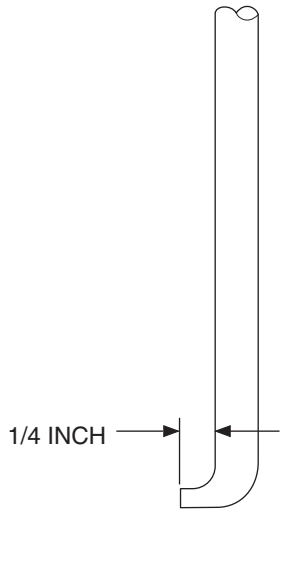
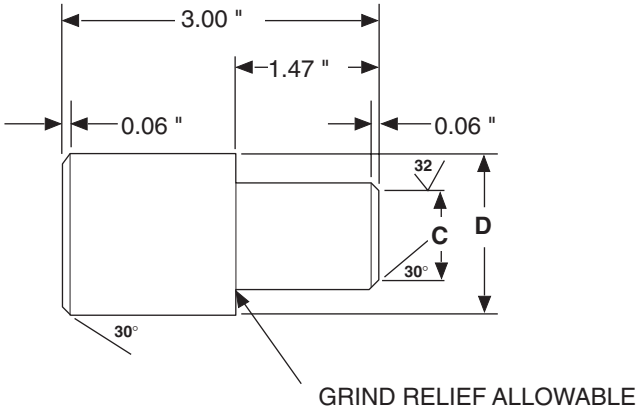


Fig. 9.39 Seal Removal Tool

5. A lip seal installation bar made from bar stock which is 1-3/4" in diameter by 2" long. Break edges slightly.



C = 1.054 PLUS 0.000, MINUS 0.002"
D = 1.250" DIAMETER

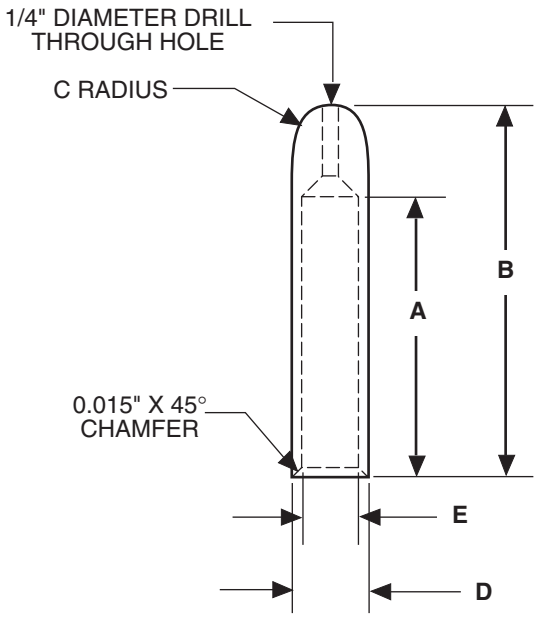
MA0811

Fig. 9.40 Bushing Installation Tool

6. The following tools will also be required:
   - arbor press
   - awl
   - steel ball, 1-1/2" diameter
   - clean lint free cloths
   - deburring tool (an old file with the cutting teeth ground off)
   - machinist's hammer
   - soft hammer
   - Permatex Aviation Form-A-Gasket No. 3 Non-hardening Sealant or equivalent
   - medium grit Carborundum stone
   - oil and grease
   - snap ring pliers
   - prick punch
   - scale (1/32" or 1/64" graduations)
   - small screwdriver
   - torque wrench
   - vise with 8" minimum open spread

c. General Repair Precautions

1. To facilitate repair of the pump and before any work is done, first read and understand all of the steps used in the disassembly and assembly instructions.
2. The first requirement of good maintenance of hydraulic equipment is cleanliness. Make sure you disassemble and assemble your hydraulic equipment in a clean area.



A = 3-3/8"
B = 4-1/2"
C = 9/16" R
D = 1.065 PLUS 0.000, MINUS 0.002"
E = 1.002 PLUS 0.002, MINUS 0.000"

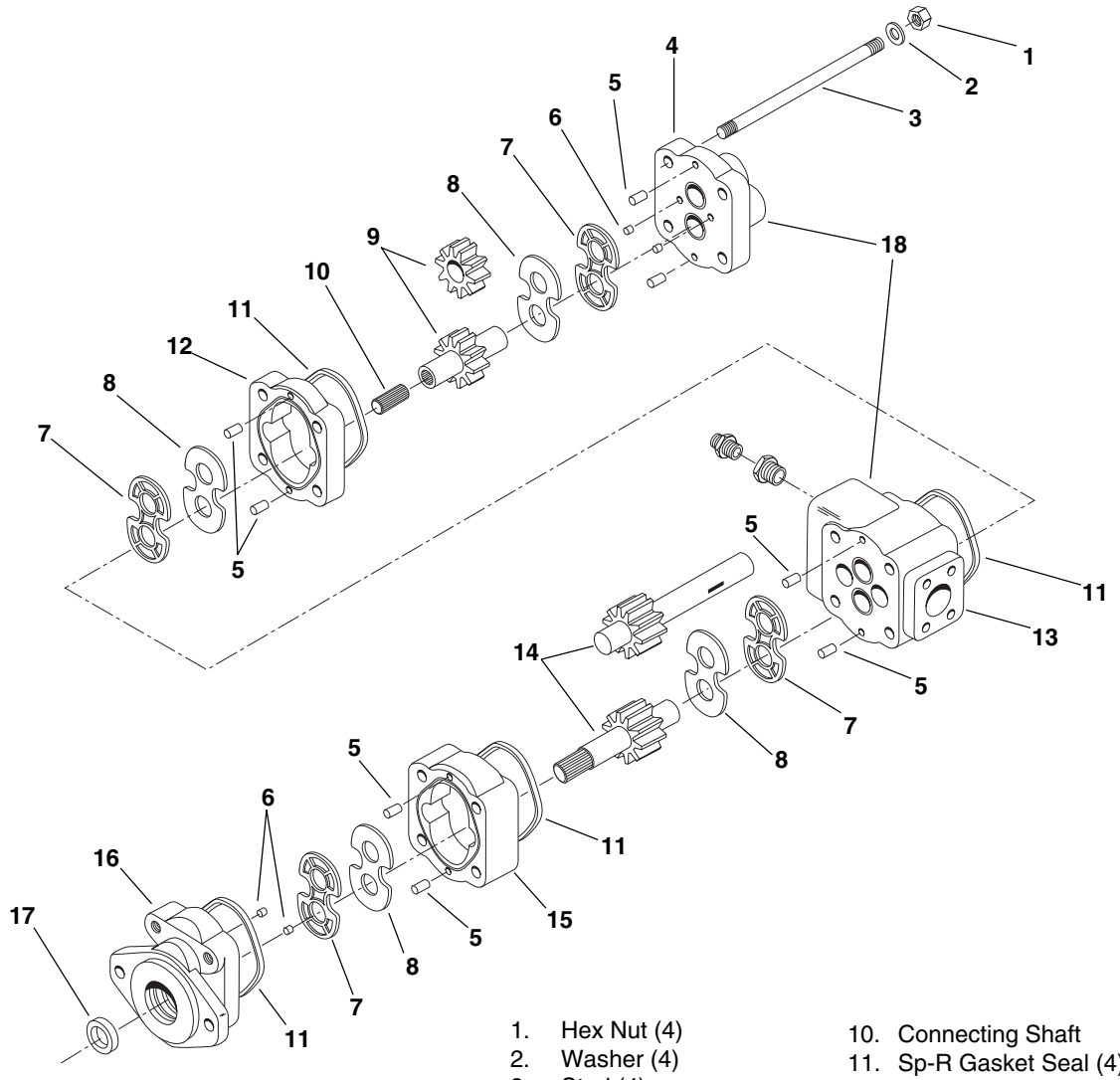
MA0821

Fig. 9.41 Special Steel Sleeve

3. If prying off sections becomes necessary, take extreme care not to mar or damage machined surfaces. Excessive force while prying can result in misalignment and serious damage to parts.
4. Match mark exterior surface of housings before separating the parts. Align match marks during assembly.
5. Gears are closely matched. Gears must be kept together as sets when removed from a unit. Handle with care to avoid damage to the journals or teeth. Avoid touching gear journals. **Always replace matched parts as a set.**
6. Do not grip machined surfaces in a vise to prevent damage to fine surfaces.
7. If parts are difficult to fit during assembly, tap gently with a soft hammer. Never use an iron or steel hammer to tap parts.
8. Never hammer bushings into bores; use an arbor press.

d. Disassembly Instructions

1. Prepare to disassemble the pump by placing it in a vise with the drive shaft pointing down.
2. Use a socket wrench to remove four hex nuts (1, Fig. 9.42), studs (3), and washers (2).
3. Lift off port end cover (4). If prying is necessary, be careful not to damage the machined surfaces. Dowel pins (5) will remain in either port end cover or gear housing. Do not remove dowel pins unless damaged.
4. Remove seal (7) and thrust plate (8).
5. Carefully remove drive and driven gear set (9). Avoid tapping the gear teeth together or against other hardened surfaces to avoid possible chipping. Keep the matched gears in a set together.
6. Remove seal (11). Lift gear housing (12) from the bearing carrier. If prying is necessary, take care not to damage machined surfaces.
7. Lift or pry off the bearing carrier housing (13). Take care not to damage contact face and edges. Dowel pins will remain in either the bearing carrier or the gear housing. Do not remove dowel pins unless damaged.



1. Hex Nut (4)
2. Washer (4)
3. Stud (4)
4. Port End Cover
5. Dowel Pin (8)
6. Plug (4)
7. Channel Seal (4)
8. Thrust Plate (4)
9. Gear Set
10. Connecting Shaft
11. Sp-R Gasket Seal (4)
12. Gear Housing
13. Bearing Carrier Housing
14. Gear Shaft Set
15. Gear Housing
16. Shaft End Cover
17. Lip Seal
18. Bushing (8)

Fig. 9.42 Main Tandem Pump Exploded View

8. Remove connecting shaft (10). Remove thrust plate (8), seal (7) and seal (11).
9. Remove integral gear set (14). Keep these together as they are a matched set. Be careful not to damage the machined surfaces of the gears.
10. Remove thrust plate (8), seal (7) and seal (11).
11. Lift or pry off the first section gear housing (15). Be careful not to damage machined surfaces.
12. Remove thrust plate (8), seal (7) and seal (11).
13. Grip the shaft end cover (16) in a vise with the mounting face down. Remove double lip seal (17) by inserting the special seal removal tool (Fig. 9.39) into the notch between the double lip seal and the shaft end cover. Tap the seal out and discard. Remove and discard all rubber and polymer seals.

e. Cleaning

Clean metal tandem pump components in an approved cleaning solvent and blow dry.

f. Inspection, Repair and Replacement

1. If either a dowel (5 Fig. 9.42) or a dowel hole is damaged, the dowel or machined casting, or both, must be replaced. Pull defective dowels as required.
2. Examine thrust plates (8,) and replace if necessary. The thrust plates seal the gear section at the sides of the gears. Wear here will allow internal slippage, that is, oil will bypass within the pump. A maximum 0.002" (0.05 mm) wear is allowable. Replace thrust plates if they are scored, eroded or pitted. Check center of thrust plates where the gears mesh. Erosion here indicates oil contamination. Pitted thrust plates indicate cavitation or oil aeration. Discolored thrust plates indicate overheating, probably due to insufficient oil.
3. Examine the drive and driven gear set (9). Replace as a matched set if there is scoring on the gear hubs; scoring, grooving, or burring of the outside diameter of the teeth, or nicking, grooving, or fretting of teeth surfaces.
4. Examine the gear housings (12 and 15) and replace it if necessary. Wear in excess of 0.007 inch (0.18 mm) cutout necessitates replacement of the gear housing. Place a straightedge across bore. If you can slip a 0.007 inch (0.18 mm) feeler gauge under the straightedge in the cutout area, replace the gear housing. Pressure pushes the gears against the housing on the low pressure side. As the hubs and bushings wear, the cutout becomes more pronounced. Excessive cutout in a short period of time indicates excessive pressure or oil contamination. If the relief valve settings are within prescribed limits, check for shock pressures or tampering. Withdraw oil sample and check it and tank for dirt. Where cutout is moderate, 0.007 inch (0.18 mm) or less, gear housing is in good condition and may be reused.
5. Examine integral gear shaft set (14). Examine the gears as described in paragraph 3 above. Examine all drive shafts and replace if there is any wear detectable by touch in the seal area or at the drive coupling. Maximum allowable wear is 0.002 inch (0.05 mm). Wear in the shaft seal area indicates oil contamination. Wear or damage to splines, keys, or keyways necessitates replacement.
6. If gears are replaced, bushings (18) must be replaced. Bushings should fit into bore with a heavy press fit. Inspect all bushings for scoring or discoloration and replace if necessary. Use a bushing puller (Fig. 9.38) to remove bushings.
7. Replace all rubber and polymer seals, including all O-rings, channel seals, shaft seals and gasket seals.
8. Examine the plugs (6) in the shaft end and port end covers to make sure that the plugs are in the proper position and tight. There should be two plugs in both the shaft end and port end. Replace any plugs which are damaged or cannot be tightened.

g. Assembly

1. Stone all machined surfaces with a medium grit Carborundum stone.
2. If bushings have been removed, deburr the bushing bores with fine emery cloth.
3. Rinse parts in an approved solvent. Air blast all parts and wipe with a clean lint free cloth before starting assembly.
4. Grip shaft end cover (16, Fig. 9.42) in vise with mounting face down. If plugs (6) were removed, screw new plugs in tightly. Stake plug with prick punch at both ends of screwdriver slot and around edges. Peen the edge of the hole 1/32 to 1/16" (0.79 mm to 1.59 mm) with a 1-1/2" diameter steel ball.

***NOTE**: If new plugs are being installed, coat threads with Loctite® Threadlocker 242.*

5. If removed, install new dowels (5) as needed. Be sure dowel holes are clean and free of burrs. Gently tap in new dowels with a soft hammer.
6. Assembly of bushings in shaft end cover (16), bearing carrier housing (13) and port end cover (4).
   a. Install any new bushings in drive bores with groove to top of unit (12 o'clock). Assemble bushings in driven bores with the groove to bottom of unit (6 o'clock).
   b. Press bushings into the bores, one at a time using the special installation tool (Fig. 9.40) and an arbor press. Be sure the grooves are positioned as stated in step 6a. Bushings must be pressed into the bores flush with the casting face. Be sure to support the castings so they are square and level.
   c. Repeat Steps 1 and 3 (stone and rinse parts).
7. Before inserting a new lip seal (17) in the shaft end cover (16), coat the outer edge of the lip seal and its recess with Permatex Aviation Form-A-Gasket No. 3 non-hardening sealant or equivalent. With the metal side of the lip seal up, press it into the mounting flange side of the shaft end cover with an arbor press and special installation bar (paragraph 9.4.2b). Be careful not to damage the lip of the seal. Press in until flush with the recess. Wipe off excess sealant.
8. Lubricate new gasket seals (11) and insert them into the grooves in <u>both</u> sides of all gear housings.
9. Position the first gear housing (15) over the shaft end cover (16) and dowels. Tap it with a soft hammer until it rests tightly against the shaft end cover. Be careful not to pinch the gasket seal (8). Also be sure the large rounded core is on the inlet side
10. Assemble new channel seals (7) into the grooves in all the thrust plates (8) with the flat side of the seal facing away from the thrust plate (Fig. 9.43).
11. Gently slip thrust plate (8) with seal (7) through the gear housing and into place on the shaft end cover (16). The channel seal should face the shaft end cover. The relief groove in the plate should face the outlet side of the pump.
12. Slide the driven gear and shaft through the housing (15) and into the bushing in the shaft end cover (16). Coat the steel sleeve tool (Fig. 9.41) with hydraulic oil inside and out. Place the lightly lubricated drive shaft inside the sleeve and slide both through the shaft end cover with a twisting motion until the integral gear rests against the thrust plate. Avoid damaging the double lip seal (17). Squirt clean hydraulic oil over the gears.
13. Slip thrust plate (8) with seal (7) over gear journals and into housing bore. The flat side of the seal should face up with the relief groove facing the outlet side.
14. Position the bearing carrier housing (13) over the gear housing (15) so that the bushings receive the journals of the drive and driven gears. Be sure to line up dowel pins with the dowel holes
15. Insert the connecting shaft (10) into the spline of the drive gear shaft. Position the second gear housing (12) on the bearing carrier housing as described in step 8.
16. Place the thrust plate (8) with seal (7) in the gear housing as described in step 11. Insert the drive and driven gears of the second section gear set (9) in their respective bearings. Make certain the gears are in contact with the face of the thrust plate.
17. Slip thrust plate (8) with seal (7) over gear journals and into housing bore. The flat side of the seal should face up with the relief groove facing the outlet side.
18. Place port end cover (4) over the gear journals. Align the dowel pins (5) with the holes in the mating casting. Being careful not to pinch the gasket seal (11), tap the port end cover lightly in the center between bearing bores to engage the dowels and to move parts together in a final seating.

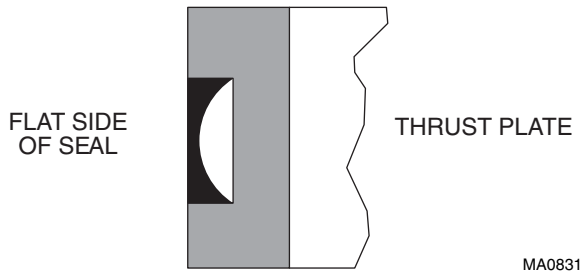


Fig. 9.43 Channel Seal Installation

19. Thread four studs (3), washers (2) nuts (1) into shaft end cover (16) and tighten alternately or cross corner. Rotate the drive shaft with a 6 inch wrench to make certain there is no binding in the pump. After the fasteners are tight and you are sure there is no internal binding, torque the diagonally opposite fasteners to 200 lb-ft (271,2 N m).

h. Installation

1. Place a new gasket (15, Fig. 9.37) and main tandem pump (14) in position on the transmission and secure using two hex head capscrews (12) and lock washers (13). Torque capscrews to 75 lb-ft (101,7 N m).
2. Fill the pump inlet port and outlet ports with hydraulic oil to provide initial lubrication
3. Install elbow (11) and connector (10) to the pump outlets.
4. Install small pump outlet hose assembly (8) and large pump outlet hose assembly (9).
5. Install O-ring (7) in elbow (5). Position clamp halves (6) and elbow (5) on pump inlet and secure with four lock washers (4), and four hex head capscrews (3). Torque capscrews to 75 lb-ft (101,7 N m).
6. Check hose clamp (1) to be sure it is secure.

i. Recommended Test Procedure

Perform pump testing in accordance with procedures in SAE Handbooks. Refer to Hydraulic Pump Test Procedure SAE J745c.

1. Be sure to run the pump in the clockwise direction (from the drive end). Driving the pump in the wrong direction will build up pressure behind the shaft seal, damaging it and requiring replacement.
2. Be sure there is an adequate supply of oil for the pump, at least one gallon of oil for each gpm of pump capacity.
3. If one section of the tandem pump is being tested, make sure that the other section which is not being tested is adequately supplied with oil. If any of the sections run dry, or if plugs are left in ports, serious and permanent damage will result.
4. Use a good quality Grade 46 hydraulic oil rated at 215 SSU at 100 °F ±5 °F (38 °C ± 3 ° C). Refer to Specifications in this section.
5. The feed line must be of adequate size with no more than 5" mercury vacuum adjacent to the pump inlet. As a rule, the feed line must provide a feed flow velocity not in excess of 8 feet per second.
6. Run the pump at least two minutes at no load and moderate speed (not below 400 or over 1500 rpm). If the pump becomes excessively hot, shut down immediately and locate the problem source.
7. Gradually increase pressure on pump, in 500 psi increments until the desired test pressure has been reached. This should take about five minutes.
8. Average Output Specifications at 3500 psi (241 bar)

Pump Section	Speed (RPM)	Output (GPM)
30 gpm	1000	11
30 gpm	1500	18
30 gpm	2000	24
30 gpm	2500	30
15 gpm	1000	7
15 gpm	1500	11
15 gpm	2000	15.5
15 gpm	2500	20

j. Recommended Start-up Procedure for New or Rebuilt Pump

After connecting the lines and mounting the replacement unit, start-up as follows:

1. Make sure that the pump suction line is securely clamped at the pump inlet and the reservoir.
2. Disconnect the fuel run solenoid to prevent the engine from starting.
3. Turn the ignition switch to START position and crank the engine for 15 to 25 seconds. This will prime the main tandem pump.
4. Turn the ignition switch OFF.
5. Reconnect the fuel run solenoid.

IMPORTANT: *DO NOT operate <u>any</u> boom or steering functions during pump test.*

6. Start the engine and operate the pump at least two minutes at no load and at a speed of over 400 rpm but below 1500 rpm. During this break-in period, the unit should run free and not develop and excessive amount of heat. If the unit operates properly, speed and pressure can then be increased to normal operating settings.

9.4.2 Steering and Emergency Brake Pump (S/N 7P0013 and Before)

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Slowly loosen the fittings on the steering and emergency brake pump as required to relieve any trapped pressure
3. Tag and disconnect yellow ground wire from ground terminal of motor (15, Fig. 9.44).
4. Tag and disconnect wire from switch terminal on solenoid (10).
5. Disconnect red electrical cable from power terminal on solenoid.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

6. Tag, disconnect, and plug the hydraulic supply hose (1) at the connector (2). Wire or otherwise secure the hose to the frame to hold it up and prevent oil from draining out of the reservoir. Cap the connector.
7. Tag, disconnect, and plug the pump outlet hose (3) at the elbow (4). Cap the elbow.
8. Have an assistant support the pump and motor assembly while removing two capscrews (5) and lock washers (6) and remove from the forklift.

1. Supply Hose
2. Connector
3. Pump Outlet Hose
4. Elbow
5. Capscrew (2)
6. Lock Washer (2)
7. Terminal Cable
8. Screw (2)
9. Washer (2)
10. Solenoid
11. Capscrew (4)
12. Washer (4)
13. Pump
14. Coupling
15. Motor
16. Ground Strap

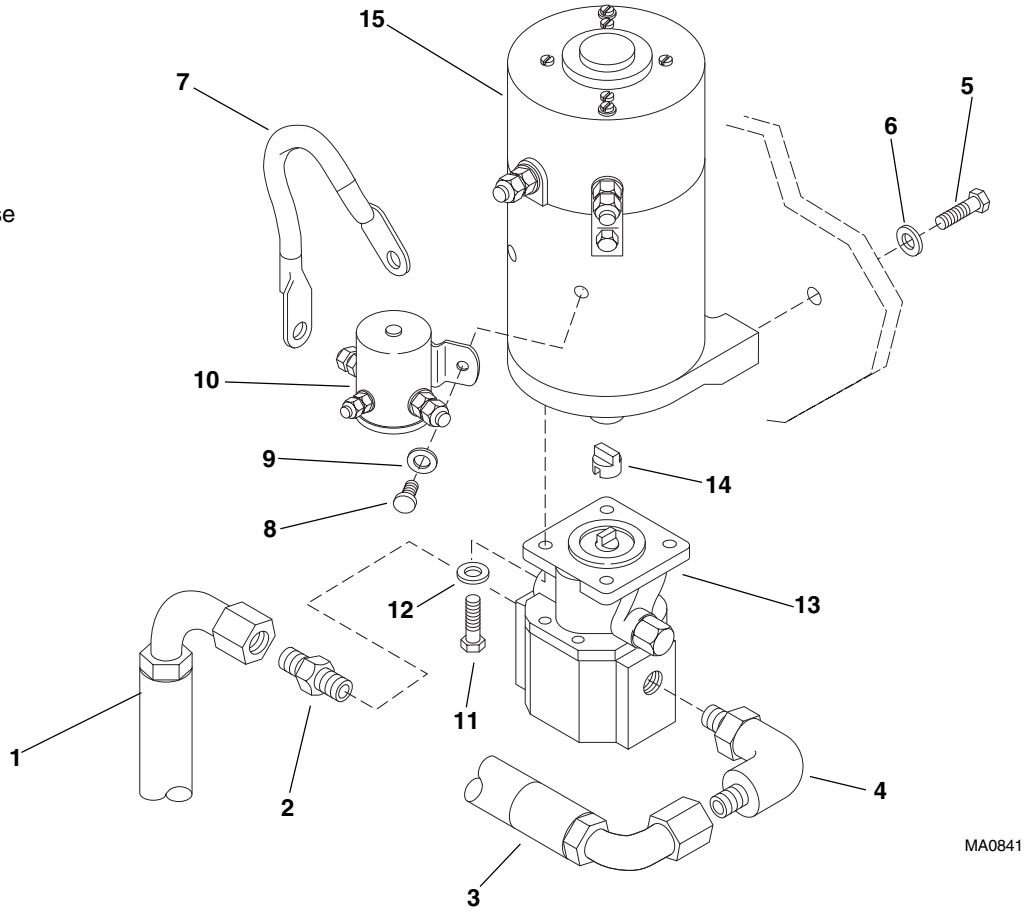


Fig. 9.44 Steer and Emergency Brake Pump and Motor (S/N 7P0013 and Before)

b. Disassembly

1. Remove connector (2, Fig. 9.44) and elbow (4) from the pump (13) if necessary.
2. Disconnect black electric terminal cable (7) from the solenoid cable terminal and the motor power terminal.
3. Remove solenoid (10) from motor (15) by removing two screws (8) and washers (9).

NOTE: *Normally the pump and motor assembly is replaced as a complete unit. If the unit is under warranty, do not disassemble further; refer the unit to your JLG authorized dealer. The pump (2) and motor (1) can be separated by removing four screws (11) and washers (12).*

c. Cleaning and Drying

Without submerging the motor (15, Fig. 9.44) in the cleaning solvent, clean the pump and motor assembly in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect the pump and motor assembly.
2. Discard the complete pump and motor assembly if the pump (13, Fig. 9.44) or motor (15) is damaged or defective.

e. Assembly

1. If pump and motor assembly was disassembled, install coupling (14, Fig. 9.44) on pump (13).
2. Place the motor (15) in position on the pump and secure with four screws (11) and washers (12).
3. Position the solenoid (10) on the housing of the motor and install two screws (8) and washers (9) to secure.
4. Check torque on bottom nut on the motor ground terminal and power terminal and re-torque to 100 lb-in (11,3 N m) maximum if necessary.
5. Connect black electric terminal cable (7) to the solenoid cable terminal and motor power terminal. Torque this top terminal nuts to 35 lb-in (3,9 N m) maximum.
6. Install connector (2) and elbow (4) in pump (13).

f. Installation

1. Place the pump and motor assembly on the frame and support in position.
2. Secure the pump and motor assembly to the frame with two 3/8-16 UNC-28 hex head capscrews (5, Fig. 9.44) and lock washers (6).
3. Connect the supply hose (1) and pump outlet hose (3) to appropriate pump port fittings.
4. Connect the red electrical cable to the solenoid power terminal.
5. Connect the yellow ground wire to the motor ground terminal.
6. Connect the yellow switch wire to the solenoid switch terminal.

g. Testing

Test operation of steering and emergency brake pump (para 9.1.6).

9.4.3 Steering and Emergency Brake Pump (S/N 7P0014 and After)

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning !

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Slowly loosen the fittings on the steering and emergency brake pump as required to relieve any trapped pressure
3. Tag and disconnect yellow ground wire from the end head assembly (10, Fig. 9.45).
4. Tag and disconnect wire from switch terminal on solenoid (9).
5. Disconnect red electrical cable from power terminal on solenoid.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

6. Tag, disconnect, and plug the hydraulic supply hose (1) at the connector (2). Wire or otherwise secure the hose to the frame to hold it up and prevent oil from draining out of the reservoir. Cap the connector.
7. Tag, disconnect, and plug the pump outlet hose (3) at the elbow (4). Cap the elbow.
8. Have an assistant support the pump and motor assembly while removing two capscrews (5) and lock washers (6) and remove from the forklift.

b. Disassembly

1. Disconnect black electric terminal cable (7, Fig. 9.45) from the solenoid cable terminal and the motor power terminal.
2. Remove solenoid (4) by removing two screws (8).
3. Remove check valve (11) if replacement is necessary.

NOTE: *Normally the pump and motor assembly is replaced as a complete unit. If the unit is under warranty, do not disassemble further; refer the unit to your JLG authorized dealer.*

c. Cleaning and Drying

Without submerging the motor (13, Fig. 9.45) in the cleaning solvent, clean the pump and motor assembly in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect the pump and motor assembly.
2. Discard the complete pump and motor assembly if the pump (10, Fig. 9.45), end head assembly (12) or motor (13) is damaged or defective.

1. Supply Hose
2. Connector
3. Pump Outlet Hose
4. Elbow
5. Capscrew (2)
6. Lock Washer (2)
7. Terminal Cable
8. Screw (2)
9. Solenoid
10. Pump
11. Check Valve
12. End Head Assembly
13. Motor

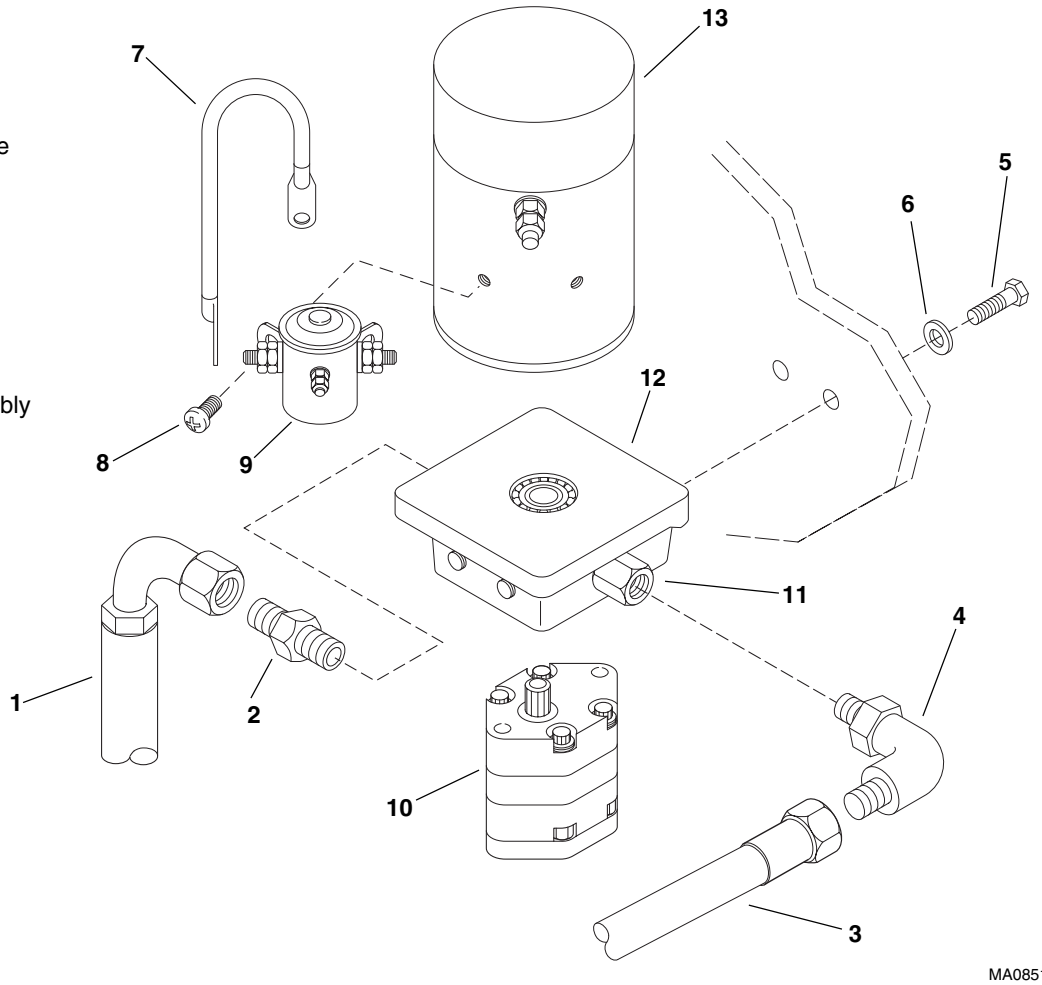


Fig. 9.45 Steer and Emergency Brake Pump and Motor (S/N 7P0014 and After)

e. Assembly

1. If the pump and motor assembly was disassembled, mount the end head assembly (12, Fig. 9.45) and pump (10) i on the motor (13) and secure.
2. Install check valve (11) in the end head assembly (12).
3. Install the solenoid (9) on the housing of the motor (13) and secure with two screws (9).
4. Connect black terminal cable (7) to the solenoid cable terminal and the motor power terminal.

f. Installation

1. Place the pump and motor assembly on the frame and support in position.
2. Secure the pump and motor assembly to the frame with two 3/8-16 UNC-28 hex head capscrews (5, Fig. 9.45) and lock washers (6).
3. Connect the supply hose (1) and pump outlet hose (3) to appropriate pump port fittings.
4. Connect the red electrical cable to the solenoid power terminal.
5. Connect the yellow ground wire to the end head assembly (12).
6. Connect the yellow switch wire to the solenoid switch terminal.

g. Testing

Test operation of steering and emergency brake pump (para 9.1.6).

9.5 TROUBLESHOOTING

Trouble	Probable Cause	Remedy
Cannot Lower Elevated load	Ruptured hoist or extend hose	Lower load using Emergency Boom Lowering instructions in Owners/Operators Manual.
	Loss of engine power or hydraulic pump failure	Lower load using Emergency Boom Lowering instructions in Owners/Operators Manual.
	Faulty main control valve	Repair main control valve (para 9.3.1).
Cavitation and Noise	Fluid level in reservoir is low	Add fluid. Refer to Owners/Operators Manual.
	Filler/breather is clogged	Clean or replace filler/breather.
	Air leaks in suction line	Using an oil can containing system fluid, squirt a little fluid on each joint of the suction line and tighten any joint where fluid stopped the noise. Double clamp if necessary.
	Loose tandem pump mounting hardware	Tighten mounting capscrews to 75 lb-ft (101,7 N m).
	Loose pump sections	Tighten hardware to 200 lb-ft (271,2 N m). Refer to para 9.4.1.
	Defective tandem pump	Repair pump (para 9.4.1).
Ruptured Hose	Damaged hose due to tight bend	Replace hose and install without tight bends or twists.
	Pressure setting for main relief valve is too high	Check and set the main relief valve (para 9.1.1).
Hose Cover Separated from Wire	Hose is twisted	Replace and make sure the hose does not turn as swivel fitting is tightened.
Damaged Threads on Fittings	Connections are too tight or cross threaded	Repair hose fittings if possible or replace hose.
Boom Hoist or Extend Function Slow or Malfunctioning	External fluid leakage at tubes, hoses or fittings	Check and tighten connections at valves, pumps and cylinders. Repair or replace faulty hose(s).
	Faulty relief valve setting	Set relief valves (para 9.1.1 and 9.1.2).
	Internal leakage in cylinders	Repair cylinders as required (para 9.2.1 and 9.2.2).
	Internal leakage in control valve	Repair control valve as required (para 9.3.1).
	Defective tandem pump	Repair tandem pump (para 9.4.1).

Trouble	Probable Cause	Remedy
Boom Hoist or Extend Function Drifts Grille Tilt Slow or Malfunctioning	Defective counterbalance valve or cylinder seals	Repair or replace cylinders seals and/or counterbalance valves as required (para 9.2.1 or 9.2.2).
	External fluid leakage at tubes, hoses or fittings	Check and tighten connections at valves, pumps and cylinders. Repair or replace faulty hose(s).
	Faulty relief valve setting	Check and set relief valve (para 9.1.3).
	Internal leakage in cylinders	Repair cylinders as required (para 9.2.3 and 9.2.4).
	Internal leakage in control valve	Repair control valve as required (para 9.3.1).
	Defective tandem pump	Repair tandem pump (para 9.4.1).
Grille Tilt Drifts	Defective grille tilt or slave cylinders	Repair or replace cylinder (para 9.2.3 and 9.2.4).
Frame Tilt Slow or Malfunctioning	External fluid leakage at tubes, hoses or fittings	Check and tighten connections at valves, pumps and cylinders. Repair or replace faulty hose(s).
	Faulty relief valve setting	Check and set relief valve (para 9.1.4).
	Internal leakage in cylinders	Repair cylinders as required (para 9.2.5).
	Internal leakage in control valve	Repair control valve as required (para 9.3.1).
	Defective tandem pump	Repair tandem pump (para 9.4.1).
Frame Tilt Drifts	Defective check valves or frame tilt cylinder	Repair or replace cylinder and check valves (para 9.2.5).
Service Brakes Grab	Excessive hydraulic pressure	Adjust pressure reducing valve (para 9.1.5).
	Low disc brake oil	Check and add oil to planetary wheel ends. Refer to Owners/Operators manual.
	Brake pedal not adjusted correctly	Adjust pedal linkage (para 4.3.1).
Service Brakes Spongy	Air in brake line	Bleed brake lines (para 9.3.2g).
	Insufficient hydraulic pressure	Adjust pressure reducing valve (para 9.1.5).

Trouble	Probable Cause	Remedy
Service Brakes Fail to Release	Brake pedal not adjusted correctly	Adjust pedal linkage (para 4.3.1).
	Faulty brake valve plunger, piston, or spring	Repair brake valve as required (para 9.3.2).
Service Brake Failure	Ruptured hydraulic hose	Replace hose. Bleed brake lines (para 9.3.2g).
	Faulty brake valve spring, plunger, piston or valve	Repair brake valve as required (para 9.3.2).
	Pressure reducing valve failure	Install pressure reducing valve cartridge (para 9.3.7).
	Insufficient pressure at sequence valve	Adjust or replace cartridge (para 9.3.5) .
	Defective discs or leakage within brake	Repair service brakes using repair kits as required (para 5.2.2).
Park Lock Brake Fails to Release	Ruptured hydraulic hose	Replace hose.
	Defective park lock switch	Replace park lock switch (para 10.7.4).
	Park lock release valve fails to shift	Replace solenoid or valve (para 9.3.3).
	Defective park lock	Install seal kit or other kits in park lock as required (para 5.2.6).
Park Lock Brake Fails to Set	Corrosion, binding or worn parts in park lock	Install repair kits in park lock as required (para 5.2.6).
	Defective solenoid	Replace solenoid (para 9.3.3).
	Defective switch	Replace switch (para 10.7.4).
Power Steering Failure (Total)	Ruptured hydraulic hose	Replace hose.
	Faulty power steering unit	Repair or replace power steering unit.
	Tandem pump failure	Repair tandem pump (para 9.4.1).
No 4-Wheel or Crab Steering or Failure to Change Mode	Defective solenoid in steer select valve	Repair steer select valve (para 9.3.4).
	Faulty steer select switch or wiring	Replace switch or repair wiring as required (para 10.7.7).
	Broken spring in steer select valve	Repair steer select valve (para 9.3.4).

Trouble	Probable Cause	Remedy
Steers too Slowly	Steer relief valve not set correctly	Check and set relief valve (para 9.1.6).
	Defective sequence valve	Install new cartridge or replace valve (para 9.3.5).
	Steering cylinder leakage	Install cylinder seal kit(s) (para 9.2.6).
Front or Rear Wheels Not Parallel in 2- or 4-Wheel Steering	Wheel misalignment	Check and adjust wheel alignment as needed per paragraph 5.2.5.
	External leakage in system	Check and tighten connections at valves, pump and cylinders. Repair or replace defective hose.
	Internal leakage in cylinder	Install cylinder seal kit(s) (para 9.2.6).
	Internal leakage in power steering unit	Repair or replace power steering unit.
	Defective steer select valve	Replace steer select valve (para 9.3.4).
Steering is Spongy or Noisy	Air in steering lines	Check and tighten loose connections. Operate steering to purge system of air.
	Faulty power steering unit	Repair or replace power steering unit.
Auxiliary Equipment Slow or Malfunctions	External fluid leakage at tubes, hoses or fittings	Check and tighten connections at valves, pumps and cylinders. Repair or replace faulty hose(s).
	Faulty relief valve setting	Check and set frame tilt relief valve (para 9.1.4).
	Internal leakage in cylinder	Repair cylinder as required (para 9.2.7).
	Internal leakage in control valve	Repair control valve as required (para 9.3.1).
	Defective tandem pump	Repair tandem pump (para 9.4.1).
Auxiliary Equipment Drifts or Creeps	Leakage in auxiliary cylinder(s)	Repair or replace cylinder(s) or check valve (para 9.2.7).
Tandem Pump Fails to Deliver Fluid	Low level in reservoir	Check and fill hydraulic reservoir as described in Owners/Operators manual.
	Filler/breather on reservoir is dirty	Clean or replace filler/breather.
	Suction strainer clogged	Clean strainer as described in Owners/Operators manual.
	Suction line is restricted or loose	Clean or replace suction line and/or tighten if loose.

Trouble	Probable Cause	Remedy
Tandem Pump Fails to Deliver Fluid	Fluid viscosity is too heavy to pick up prime	Check working temperature and service and change fluid in system if necessary
	Worn, broken or stuck parts in pump	Repair tandem pump (para 9.4.1).
Cylinder Fails to Move When Control Valve is Actuated	Faulty hose	Repair or replace hose.
	Damaged cylinder	Repair or replace cylinder as required (para 9.2).
	Defective main control valve	Inspect and repair as required (para 9.3.1).
Cylinder Movement is Jerky	Air trapped in cylinder or in hydraulic line	Inspect fluid for foam and bubbles. Check and tighten connections. Bleed cylinder and lines as required.
	Binding of cylinder rod or piston	Repair or replace cylinder (para 9.2).
	Rod seal installed improperly	Disassemble cylinder and repair (para 9.2).
	Binding of base end or rod end bearing	Repair or replace bearing in applicable component
	Defective counterbalance cartridges (Hoist cylinders)	Replace cartridges (9.2.1).
Cylinder Movement is Sluggish	Control valve not fully engaged	Engage control valve fully. Be sure that valve linkage and drain lines are unrestricted.
	Internal leakage or binding in cylinder	Repair or replace cylinder (para 9.2).
Cylinder Piston Rod Drifts or Creeps	Worn piston seals	Install cylinder seal kit (para 9.2).
	Internal leaking in control valve	Inspect control valve and install seal kit (para 9.3.1).
	Tube is out-of-round	Replace tube and install seal kit (para 9.2).
Relief Valve Doesn't Hold Pressure Setting	Spring broken or has taken a “set”	Disassemble valve, inspect and clean. Install seal and spring kit (para 9.3.6).
	Poppet stuck due to dirt or deposits	Clean all foreign material from parts and check operation (para 9.3.6). Poppets must slide freely in valve body. If poppets slide freely, install seal and spring kit. If poppets still stick, replace valve.
Directional Control Valve Does Not Return	Excessive clearances between valve body and poppets	Excessive clearances will cause internal leakage. Replace relief valve.

Trouble	Probable Cause	Remedy
Directional Control Valve Difficult to Shift	Binding valve cable linkage	Check cable linkage and lubricate or free up as required.
	Broken internal parts	Disassemble control valve and replace broken parts (para 9.3.1).
	Scored valve body bore causing leakage between spool and body	Inspect valve body and spool and replace valve section if scored (para 9.3.1).
	Broken centering spring	Disassemble valve and replace broken spring (para 9.3.1).
Directional Control Valve Does Not Return	Too much friction in linkage connecting valve to operating lever	Clean and lubricate the linkage and make sure it operates freely.
	Dirt in valve	Disassemble and clean control valve thoroughly (par 9.3.1).
Shifting of Operator Lever Fails to Cause Spool in Directional Control Valve to Shift	Sheared pin in connection to valve	Check all joints for faulty connections.
	Check main control valve forbroken spool	Replace applicable valve section.

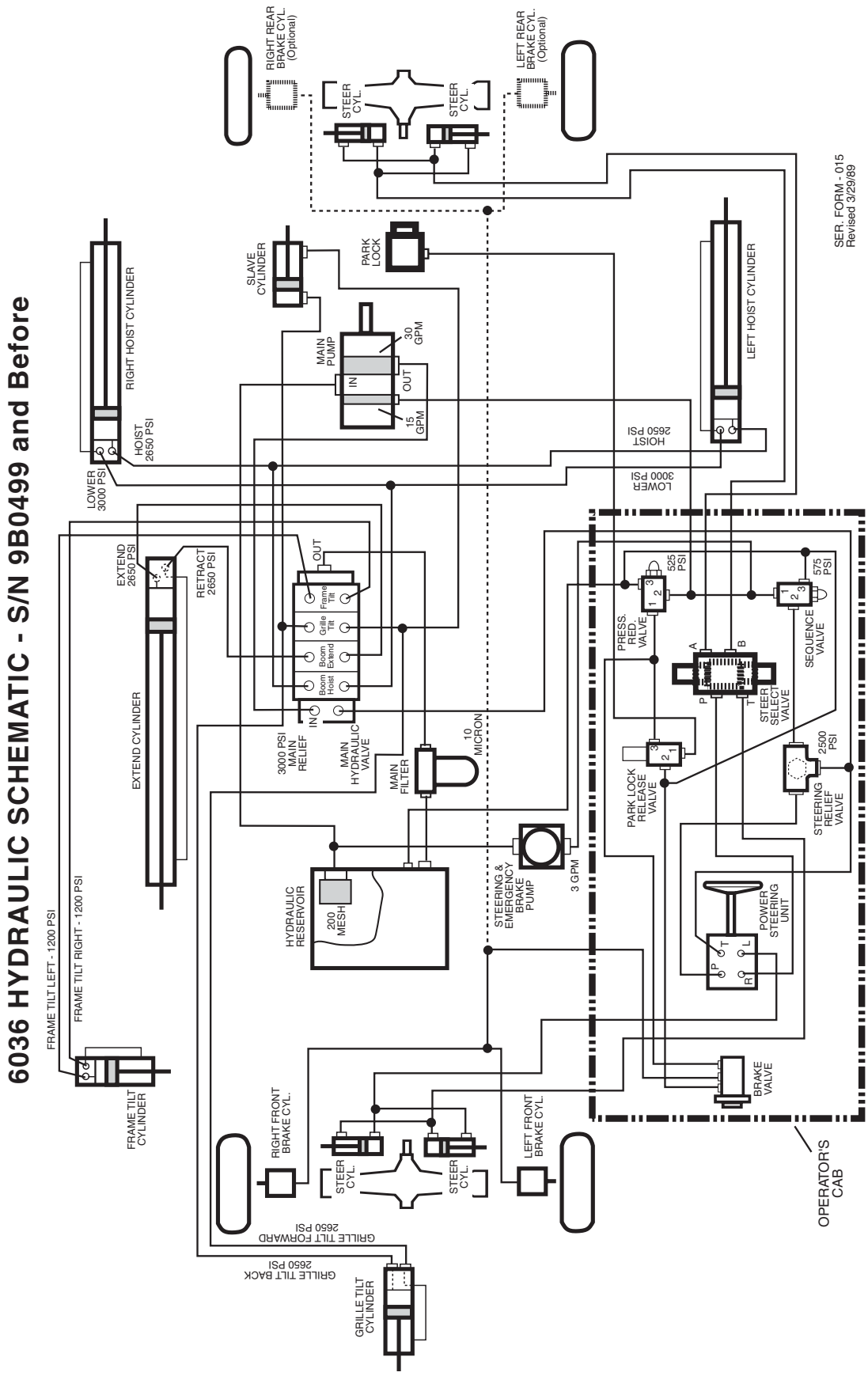


Fig. 9.46 Hydraulic Schematic for SKYTRAK 6036 Forklift — S/N 9B0499 and Before

9.6 SPECIFICATIONS

HYDRAULIC SYSTEM

System Capacity	38 gallons (143,8 liter)
Reservoir Capacity	24 gallons (90,8 liter)
Hydraulic Oil Level (all cylinders retracted)	Oil level to be visible in reservoir sight gauge when oil is cold (room temperature). Fill and maintain system level with clean, filtered hydraulic oil.
Type of Hydraulic Oil	Anti-wear hydraulic oil per ISO Grade 46 or ASTM. Viscosity SSU 215 at 100 °F (38 °C) including the following: Amoco Rykon 46 Arco Duro AW-S-215 Benz Petraulic 46-LC Chevron AW 46 Citgo Pacemaker XD-46 Gulf Harmony 46 AW Mobil DTE-25 Shell Tyllus 46 Sun Sunvis 821 WR Texaco Rando HD-46 I
Interval for Hydraulic Oil Change	Annual
Filter Capacity	1 quart (0,95 liter)
Interval for Hydraulic Filter Change	After first 50 hours of operation, every 1000 hours of operation thereafter, or **after any hydraulic component failure and repair**
Relief Valve Settings:	
Steering Relief (15 gpm pump)	2475 ± 25 psi (170,5 ± 1,7 bar)
Main Hydraulic Relief (30 gpm pump)	3000 ± 50 psi (206,7 ± 3,4 bar)
Boom Hoist Relief	2650 ± 50 psi (182,6 ± 3,4 bar)
Boom Extend Relief	2650 ± 50 psi (182,6 ± 3,4 bar)
Grille Tilt Reliefs	2650 ± 50 psi (182,6 ± 3,4 bar)
Frame Tilt Reliefs	1200 ± 50 psi (82,7 ± 3,4 bar)
Sequence Valve Setting	575 ± 25 psi (39,6 ± 1,7 bar)
Pressure Reducing Valve Setting	525 ± 25 psi (36,2 ± 1,7 bar)

9.6 SPECIFICATIONS (cont.)

HYDRAULIC SYSTEM (CONT.)

Performance:	
Boom Extend, Horizontal, No Load	12 to 15 seconds
Boom Retract, Horizontal, No Load	10 to 13 seconds
Boom Raise, No Load	11 to 13 seconds
Boom Lower, No Load	8 to 10 seconds
Grille Tilt Up, No Load	4 to 6 seconds
Grille Tilt Down, No Load	3.5 to 5.5 seconds
Frame Tilt Full Left to Full Right, No Load	8 to 12 seconds
Frame Tilt Full Right to Full Left, No Load	7 to 11 seconds
Steering Wheel Turns, Lock to Lock	4.0 to 4.5 turns

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ELECTRICAL SYSTEM

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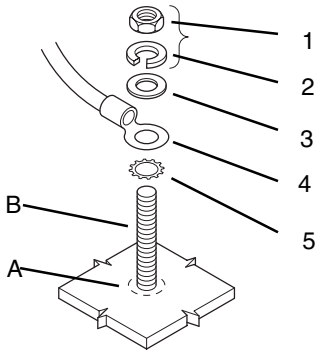


A. The area around the base of the stud (the outside diameter of lock washer (5)) shall be free of paint.
B. Stud, bolt, or capscrew
1. Hex nut or lock nut
2. Tooth or slot type lock washer
3. Flat washer
4. Electrical ground or grounds
5. Tooth type lock washer

Fig. 10.1 Recommended Sequence of Parts for Electrical Wire Grounding

10.1 SYSTEM COMPONENTS

The electrical system produces, stores, distributes and uses electricity in the operation of the forklift.

Electricity is produced by an engine-driven alternator which has a solid state voltage regulator. Current from the alternator charges the battery and powers components.

The battery provides power for starting the engine and supplements the output of the alternator during periods of peak demand.

Other electrically powered components include a horn, neutral start switch, steer select valve; park lock release valve, reverse switch and backup alarm; an hourmeter, a fuel level sender and gauge, and a cluster of warning lights.

A forklift may have the following electrical options:

- a lighting system with headlights, tail lights, directional signals, emergency flashers and rear work light;
- an enclosed cab with air circulating and heater fans and a windshield washer and wiper

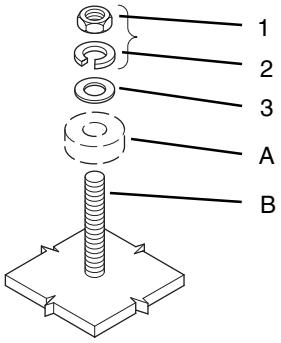
NOTE: Forklifts built thru Serial Number 9B0499 have an electrically powered hydraulic pump. This pump maintains hydraulic pressure for power steering and service and park lock brakes if engine oil pressure falls below a predetermined level. The pump is actuated by an oil pressure switch which actuates a solenoid which in turn starts the pump if engine oil pressure falls below 4 psi (0,3 bar).

10.1.1 Service Warnings and Recommendations

Warning !

- DO NOT disconnect the battery while the engine is running. This will cause a voltage surge in the alternator charging system that will immediately ruin the diodes or transistors.
- DO NOT disconnect any wiring without first stopping the engine, turning all electrical switches to the OFF position and disconnecting the battery ground cable from the battery.
- DO NOT cause a short circuit by connecting leads to incorrect terminals. Always identify a lead to its correct terminal. A short circuit or wrong connection giving reverse polarity will immediately and permanently ruin transistors and diodes.
- DO NOT connect a battery into the system without checking for correct polarity and voltage.
- DO NOT “flash” connections to check for current flow. No matter how brief the contact the transistors may be ruined.
- Wear safety glasses when working near batteries.
- All lead-acid batteries generate hydrogen gas which is highly flammable. If ignited by a spark or flame, the gas may explode violently causing spraying of acid, fragmentation of the battery, and possible severe personal injuries, particularly to the eyes.
- Avoid battery acid. In case of contact with acid, flush immediately with water.
- Charge batteries only in a well-ventilated area. Always be sure battery chargers are OFF when connecting to or disconnecting from batteries.
- See Delco Remy Service Bulletin 1B115 and 1B-116 for additional safety information and procedures.

These instructions assume that all wires are connected and routed as designed. Take into account any disconnected and rerouted wires before you begin any diagnosis. By referring to the wiring diagrams, you can test circuits for continuity or shorts by using a conventional test light, ohmmeter, multimeter or low reading voltmeter.



A. Partial sectional view of component to be grounded
B. Stud, bolt or capscrew
1. Hex nut or lock nut
2. Tooth or slot type lock washer or locking nut with slotted type lock washer
3. Flat washer

Fig. 10.2 Recommended Sequence of Parts for Electrical Grounding of a Component at a Mechanical Support

10.1.2 Effective Ground Connections

Effective ground connections are essential to the efficient operation of electrical components. The sequence for installing attaching parts at electrical grounds is shown in Figs. 10.1 and 10.2 Refer to special grounding instructions for the optional windshield washer reservoir and cab heater.

10.2 WARNING DEVICES

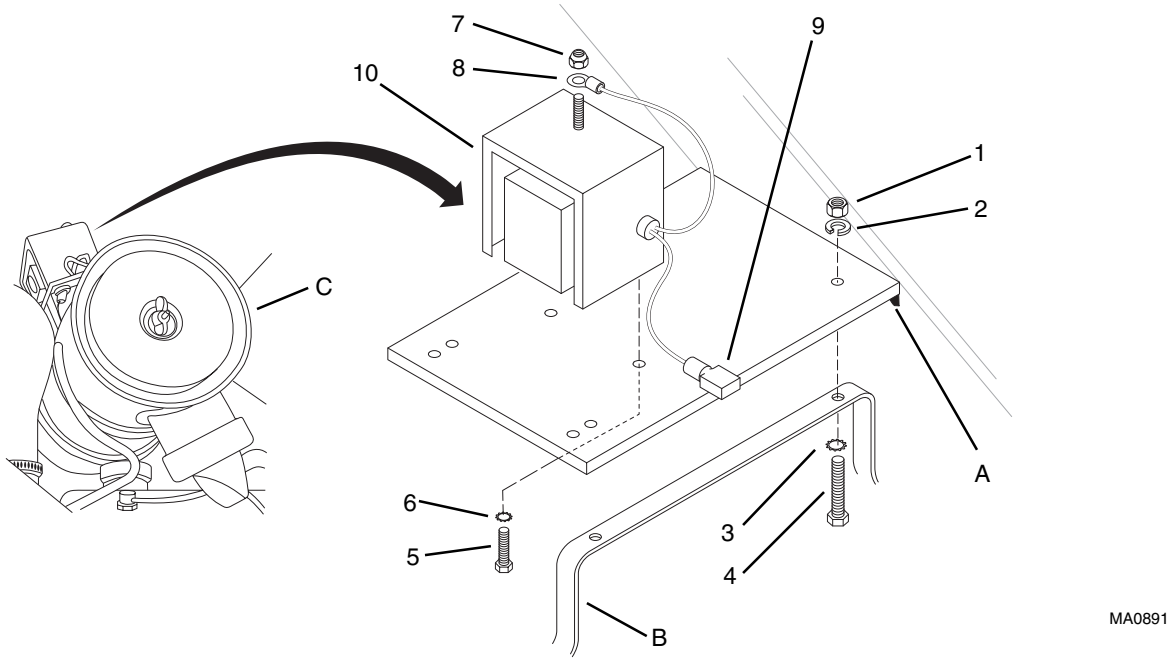
Warning devices are a horn and a backup alarm.

Warning lights indicate when engine coolant reaches 210 °F (99 °C), when engine oil pressure falls below 4 psi (0,3 bar), when the alternator isn't producing voltage, and when hydraulic oil exceeds 250 ± 5 °F (121 ± 3 °C). Please refer to paragraph 10.8.4.

10.2.1 Horn

Press the momentary-contact horn button (2, Fig. 10.39) on the control console to sound the horn (7, Fig. 10.5) which is located near the gear drop box. The sound is produced by a solenoid-actuated diaphragm in the horn that develops a resonating air column in the horn projector.

If the horn doesn't sound when you press the horn button, check for an open circuit breaker, corrosion on the horn mounting, or a loose wire. Test the horn switch for continuity when the horn button is pressed. If these tests do not reveal the problem, remove the horn from the forklift and test the horn using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply.



A. Mounting plate is welded to and supported by forklift frame
B. Air cleaner mounting band
C. Air cleaner assembly
1. Hex nut
2. Lock washer
3. Tooth type lock washer
4. Hex head bolt
5. Hex head bolt
6. Tooth type lock washer
7. Lock nut
8. Ground wire
9. Wire 31

Fig. 10.3 Backup Alarm as Viewed Through the Engine Door on Right Side of the Forklift

10.2.2 Backup Alarm and Reverse Switch

A backup alarm sounds when the forward-neutral-reverse travel select lever is in reverse. The alarm is located above the air cleaner in the engine compartment. It is energized by a reverse switch that is mounted on the transmission shifter under the left front console panel .

a. Backup Alarm Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Disconnect alarm wiring.
3. While supporting the backup alarm, remove two bolts (5, Fig. 10.3) and lock washers (6).
4. Lift backup alarm (10) from forklift.

b. Backup Alarm Disassembly

Do not disassemble the backup alarm.

c. Backup Alarm Cleaning and Drying

Without submerging the backup alarm, clean the alarm using an approved solvent and dry with a lint-free cloth.

d. Backup Alarm Inspection and Replacement

1. Test backup alarm by using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply.
2. Replace backup alarm if it malfunctions.

e. Backup Alarm Installation

1. While positioning backup alarm on mounting plate, secure alarm to plate using two lock washers (6) and two capscrews (5).
2. Connect alarm wiring.
3. Connect negative (–) cable to the batteries.
4. Test backup alarm.

f. Reverse Switch

Please refer to paragraph 10.7.6 for reverse switch instructions.

10.2.3 Park Lock Warning Light

The park lock warning light, Fig. 10.43, illuminates when the park lock switch is in the UP or FORWARD position.

a. Bulb Replacement

You will find the number of the bulb in the Electrical Specifications Table at the end of this section.

To replace the bulb within the warning light, remove the lower panel (7, Fig. 10.40) which is secured by four capscrews (6). To gain access to the bulb, pull straight downward on the lower part of the park lock warning light.

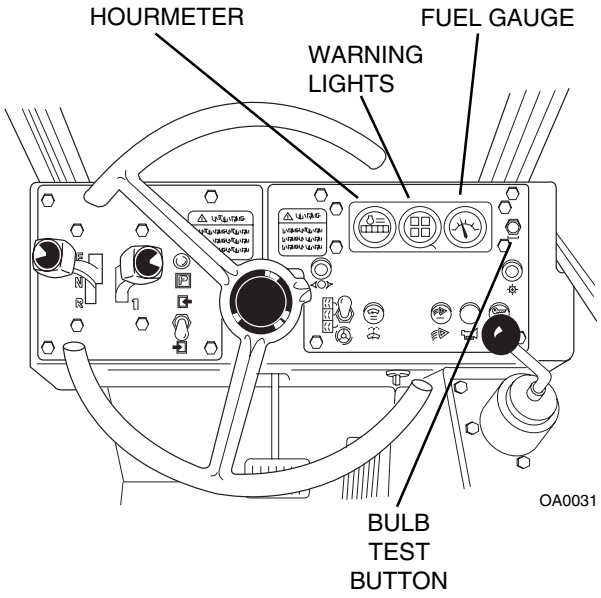
b. Light Removal

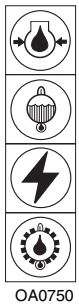
To replace the park lock warning light, continue as follows:

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Remove the lower panel (7, Fig. 10.40) which is secured by four capscrews (6). Disconnect the wiring to the light.
3. Remove the nut and locknut and lift the light from the console.

c. Light Installation

1. Position the light in the console and install locknut and nut.
2. Connect wiring to light.
3. Connect negative (–) cable to the batteries.





Engine Oil Pressure—Indicates low engine oil pressure.

Engine Water Temperature—Indicates high coolant temperature.

Alternator Charging—Indicates alternator is not charging.

Transmission Oil Temperature—Indicates high transmission Oil Temperature.

Fig. 10.4 Warning Lights Signal Dangerous Operating Conditions

10.2.4 Warning Lights

There are four warning lights in a cluster between the hourmeter and fuel gauge. When you turn the ignition key to the RUN position the Engine Oil Pressure and Alternator Charge indicators will light. This is a normal condition. While the engine is running, all lights should be OFF. However, if any of the lights go ON a potentially dangerous condition exists.

Directly to the right of the instrument cluster is a warning light bulb test button. With ignition switch in RUN and the engine OFF, depress this button to test all four warning lights. If any of the lights are burnt out, replace the bulb(s) immediately. You will find the bulb number in the Electrical Specifications Table at the end of this section.

10.3 WIRING HARNESSES

The forklift has harnesses (1 and 2, Fig 10.5) for cab and engine wiring. A forklift with an optional lighting system will have a separate lighting harness (1, Fig 10.53). Each wire within a harness is identified by a wire number on the electrical schematic and on both ends of each wire.

a. Removal

1. Remove a wiring harness only if damaged or unusable.
2. You may prefer to install the new harness as you remove the old harness.
3. Tag the terminal locations of all wires, harness clips and tie wraps as you remove the old harness as required to permit identical installation of the new harness.

b. Disassembly

When replacing wires, it is important that the correct gage size be used. Never replace a wire with one of a smaller gage size.

c. Cleaning and Drying

Clean a wiring harness using a natural bristle brush and the same detergents you would use to clean the forklift. Allow to air dry with surface temperatures not to exceed 300 °F (149 °C).

d. Inspection and Replacement

Replace a harness only if damaged or unusable. If you must splice a wire or repair one that is broken, always use rosin core solder to bond the splice. Use insulating tape to cover all splices or bare wires.

e. Installation

The harnesses are held securely in place by clips or other devices to prevent chafing or wearing of the insulation due to vibration. Be careful to install harness clips and tie wraps in the locations tagged on the forklift and the old harness in step a.

10.4 CIRCUIT BREAKERS

Circuit breakers, (1 thru 6, Fig 10.6) protect the electrical system. The breakers are mounted inside the right console on the outside cab wall below the fork and frame tilt control lever. A breaker will trip if there is a shorted or grounded wire in the applicable circuit. It will automatically reset once it cools.

A circuit breaker has a bimetallic arm and a pair of contact points. When the current exceeds preset limits, the arm gets hot, bends, and opens the contact points. This shuts off the current through the circuit and protects against damage or fire.

If a breaker continually trips, check the system for shorts, grounds or defective components.

Under normal operating conditions a circuit breaker should never require replacement. However, if a breaker doesn't automatically reset, the breaker is defective and must be replaced.

The ignition switch feed for the entire electrical system is protected by a 40 A circuit breaker (4, Fig. 10.6), the horn, backup alarm and optional cab heater fan by a 10 A circuit breaker (2), and the control circuits by two 6 A circuit breakers (1 and 3). A forklift with an enclosed cab has an additional 6 A circuit breaker (5) that protects the windshield washer/wiper switch and the circulation fan.

An optional light package includes head lights and a rear work light, and stop, directional, hazard (emergency flasher) and tail lights in a circuit which is protected by a 15 A circuit breaker (6).

a. Removal of Individual Circuit Breaker and Circuit Breaker Bracket

1. Disconnect negative (–) cable (2, Fig. 10.38) from batteries.
2. Tag and disconnect wiring from circuit breaker by removing hex nuts and lock washers.
3. Each circuit breaker is held in the circuit breaker bracket by spring tension only. Remove circuit breaker by inserting small slot screwdriver between circuit breaker bracket and left edge of circuit breaker and tilt breaker out of bracket

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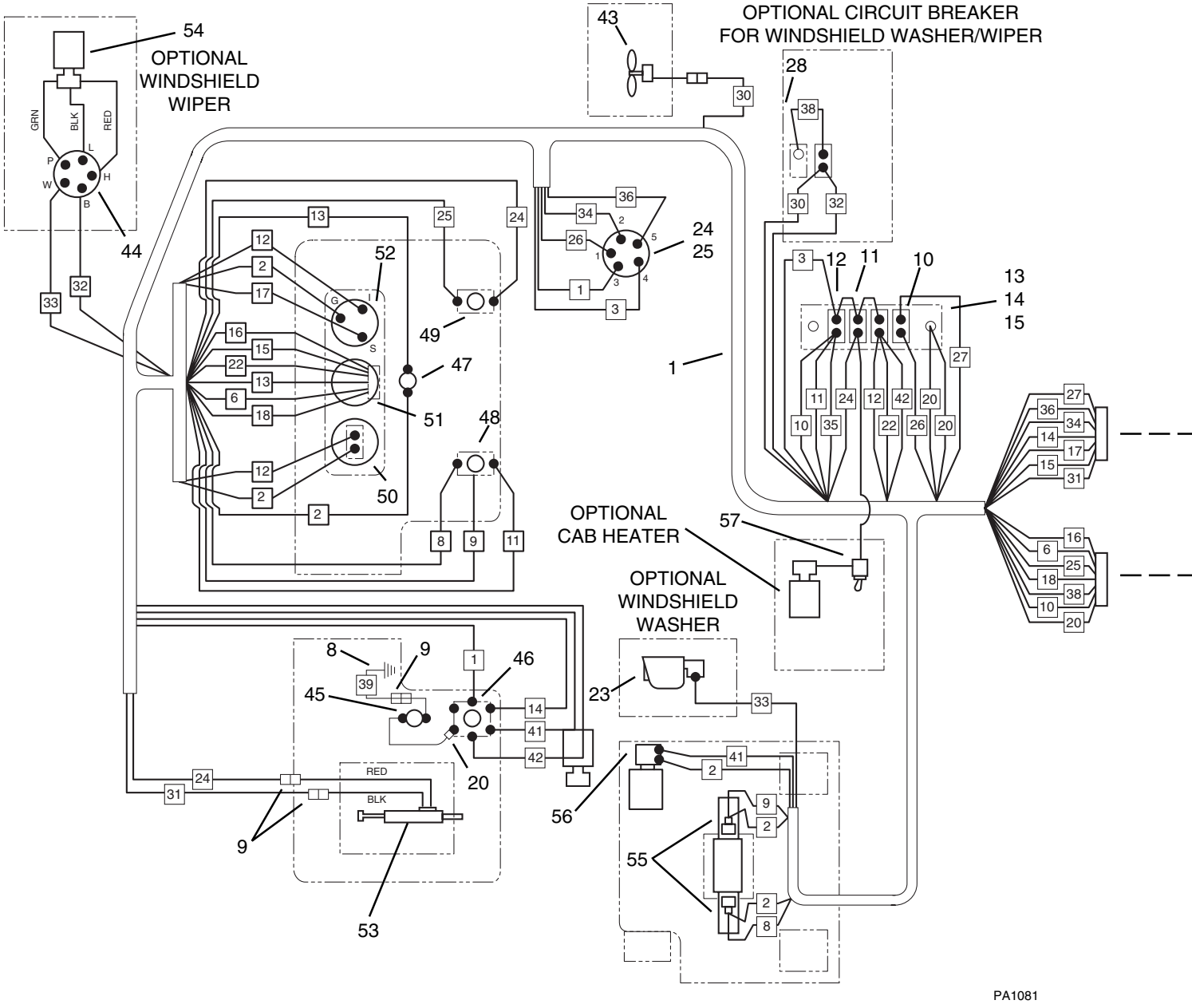
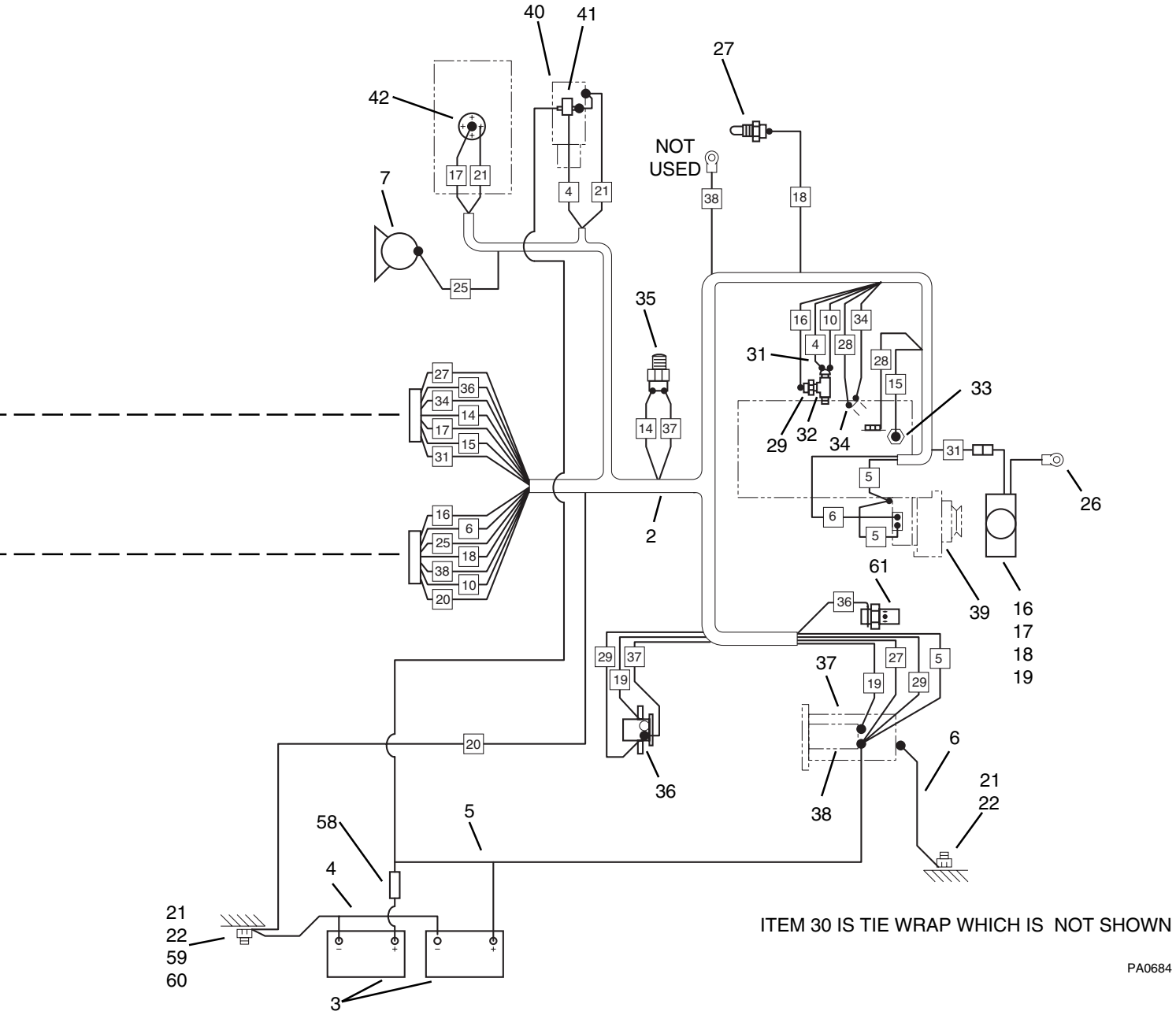


1. Cab Harness
2. Engine Harness
3. Battery, 12 Volt (2)
4. Battery Cable, negative
5. Battery Cable, positive
6. Starter Ground Cable
7. Horn
8. Wire Assembly
9. Male Terminal (4)
10. Circuit Breaker, 40 A
11. Circuit Breaker, 10 A
12. Circuit Breaker, 6 A (2, 3 are required if forklift has an enclosed cab)
13. Circuit Breaker Bracket
14. Hex Nut, 1/4 (2)
15. Lock Washer, 1/4 (2)
16. Backup Alarm
17. Capscrew, hex hd, 5/16 NC x 3-1/2 (2)
18. Hex Nut, 5/16 (2)
19. Lock Washer, 5/16 (2)
20. Ring terminal #6
21. Hex Nut, 3/8 (2)
22. Lock Washer, 3/8 (2)
23. Washer Reservoir Assembly
24. Ignition Switch with Keys
25. Ignition Key
26. Eyelet terminal, 1/4
27. Transmission Temperature Sender
28. Wire Assembly (closed cab only)
29. Engine Low Oil Pressure Sender
30. Tie Wrap (9, not shown)

Fig. 10.5 Drawing 1 Cab Harness and Components of Electrical System



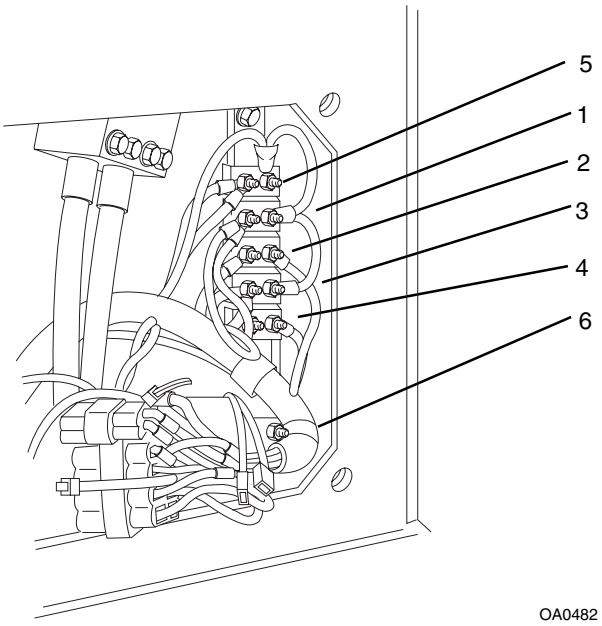
31. Emergency Pump Oil Pressure Sender
32. Street Tee, 1/8 NPT
33. Water Temperature Sender
34. Fuel Run Solenoid
35. Neutral Start Switch
36. Starter Relay
37. Starter
38. Starter Solenoid
39. Alternator
40. Electric Motor for Brake and Steering Hydraulic Pump
41. Solenoid for Electric Motor
42. Fuel Level Sender
43. Air Circulation Fan
44. Windshield Washer/Wiper Switch
45. Park Lock Brake Light
46. Park Lock Brake Switch
47. Test Switch
48. Steer Select Switch
49. Horn Button
50. Hourmeter
51. Warning Lights Gauge
52. Fuel Gauge
53. Reverse Switch
54. Windshield Wiper Motor
55. Steer Select Valve Solenoid (2)
56. Park Lock Release Valve Solenoid
57. Heater Switch Kit
58. Protection Conduit
59. Shake Proof Washer, 3/8 (2)
60. Capscrew, hex head, 3/8-16 x 1 (2)
61. Thermo Start Plug

Fig. 10.5 Drawing 2 Engine Harness and Components of Electrical System

Electrical System Circuits

Use with Fig. 10.5 Electrical System

Wire No.	Color	Gauge	From	To
1	Black	14	Ignition Key Switch (24)	Park Lock Brake Switch (46)
2	White	14	Hour Meter (50)	Ground
2	White	14	Warning Lights Test Switch (47)	Ground
2	White	14	Fuel Level Gauge (52)	Ground
2	White	14	Steer Select Solenoid (55)	Ground
2	White	14	Steer Select Solenoid (55)	Ground
2	White	14	Park Lock Release Valve Solenoid (56)	Ground
3	Red	10	6 A Circuit Breaker (12)	Ignition Key Switch (24)
4	Yellow	14	Engine Low Oil Pressure Switch (31)	Brake Hydraulic Pump Solenoid
5	Yellow	8	Alternator (39)	Starter Solenoid (38)
6	Yellow	16	Alternator (39)	Alternator Warning Light (51)
7	Not Used			
8	Yellow	14	Steer Select Switch (48)	Steer Select Solenoid (55)
9	Yellow	14	Steer Select Switch (48)	Steer Select Solenoid (55)
10	Red	14	6 A Circuit Breaker (12)	Low Oil Pressure Switch (31)
11	Red	14	6 A Circuit Breaker (12)	Steer Select Switch (48)
12	Red	16	6 A Circuit Breaker (12)	Hourmeter (50)
12	Red	16	6 A Circuit Breaker (12)	Fuel Level Gauge (52)
13	Yellow	16	Warning Lights Gauge (51)	Warning Lights Test Switch (47)
14	Black	14	Park Lock Brake Switch (46)	Neutral Start Switch (35)
15	Yellow	16	Water Temperature Switch (33)	Water Temperature Light (51)
16	Yellow	16	Engine Oil Pressure Switch (29)	Engine Oil Pressure Light (51)
17	Yellow	16	Fuel Level Sender (42)	Fuel Gauge (52)
18	Yellow	16	Transmission Temperature Switch (27)	Transmission Warning Light (51)
19	Black	10	Starter Relay (36)	Starter Solenoid (38)
20	Yellow	12	Circuit Breaker Bracket (13)	Frame Ground at Battery
21	Yellow	16	Fuel Level Sender (42)	Hydraulic Pump (40) Case Ground
22	Red	16	6 A Circuit Breaker (12)	Warning Lights Gauge (51)
23	Not Used			
24	Red	14	10 A Circuit Breaker (11)	Horn Button Switch (49)
24	Red	14	10 A Circuit Breaker (11)	Reverse Switch (53)
25	Yellow	14	Horn Button Switch (49)	Horn (25)
26	Red	10	40 A Circuit Breaker (10)	Ignition Key Switch (24)
27	Red	10	40 A Circuit Breaker (10)	Starter Solenoid (38)
28	Yellow	16	Fuel Run Solenoid (34)	Ground to Engine
29	Black	10	Starter Relay (36)	Starter Solenoid (38)
30	Red	14	6 A Circuit Breaker (12)	Air Circulation Fan (43)
31	Yellow	14	Reverse Switch (53)	Backup Alarm (16)
32	Red	14	6 A Circuit Breaker	Washer/Wiper Switch (44)
33	Yellow	14	Windshield Washer (23)	Washer/Wiper Switch (44)
34	Yellow	16	Ignition Key Switch (24)	Fuel Run Solenoid (34)
35	Yellow	16	Not Used	
36	Black	10	Ignition Key Switch (24)	Thermo Start Plug (61)
37	Black	14	Starter Relay (36)	Neutral Start Switch (35)
38	Yellow	16	Not Used	
38	Yellow	16	6 A Circuit Breaker (12)	10 A Circuit Breaker (10)
39	White	14	Park Lock Brake Light (45)	Ground
40	Not Used			
41	Yellow	14	Park Lock Release Valve Solenoid (56)	Park Lock Brake Switch (46)
42	Yellow	14	6 A Circuit Breaker	Park Lock Brake Switch (46)



1. Circuit breaker, 6 A, protects steering select valve circuit
2. Circuit breaker, 10 A, protects horn and backup alarm (and optional cab heater fan) circuit
3. Circuit breaker, 6 A, protects instrument panel, park lock solenoid switch
4. Circuit breaker, 40 A, protects ignition system feed for entire electrical system
5. Circuit breaker, 6 A, protects enclosed cab windshield washer/wiper and circulation fan circuits (this breaker is optional and will not be found on forklifts with an open cab)
6. Circuit breaker, 15 A, protects the optional lighting package

Fig. 10.6 Circuit Breakers

4 Disconnect wiring from all of the circuit breakers in the bracket.

5. Remove two nuts, lock washers and two washers and slide bracket over the studs.

b. Installation of Circuit Breaker Bracket and Individual Circuit Breaker

1. Slide circuit breaker bracket over two studs and secure using two washers, lock washers and hex nuts.
2. Position the terminal marked “BAT” on the circuit breaker terminal plate to your right and snap each circuit breaker into bracket using a small slot screwdriver.
3. Secure tagged wiring to respective terminals using lock washers and hex nuts.
4. Connect battery ground cable to the battery.
5. Check operation of circuits.

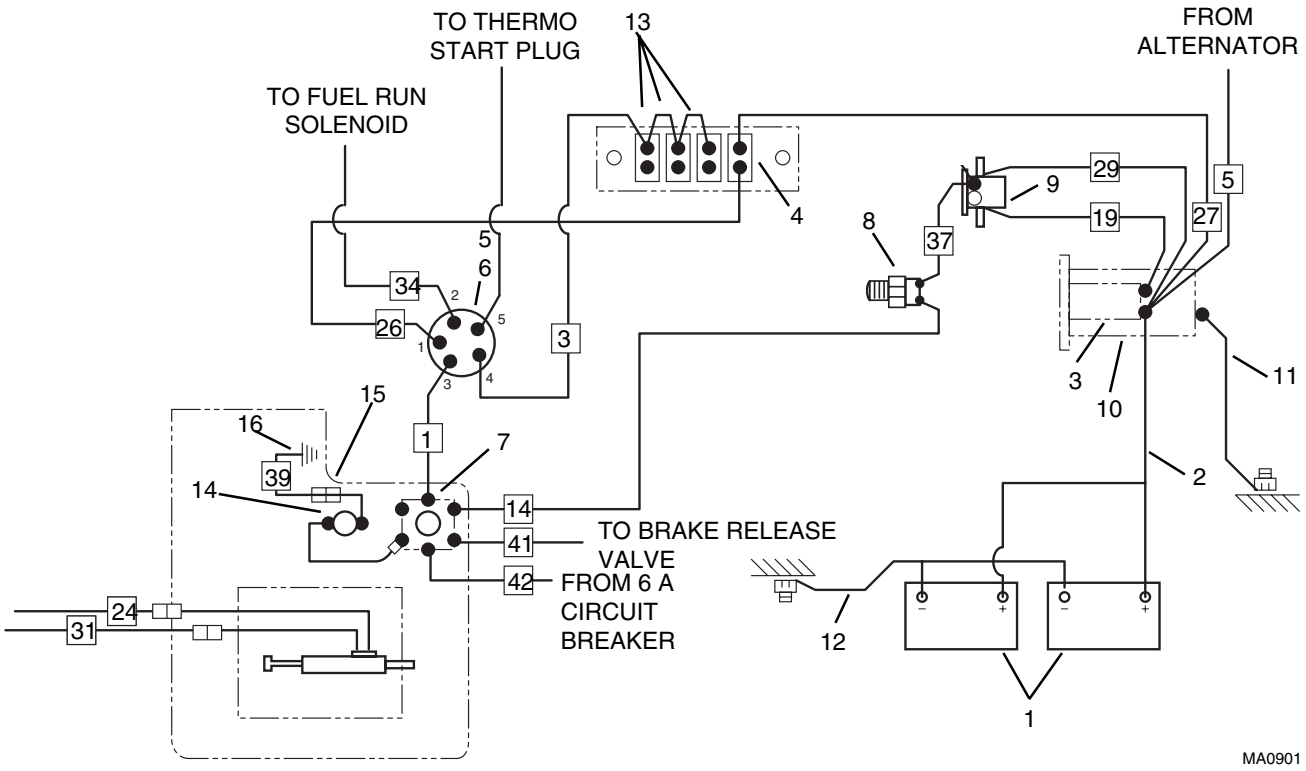
10.5 STARTING CIRCUIT

When you turn the ignition key to start the engine with the transmission in neutral, the starting circuit actuates a starter relay, a starter solenoid, a starter and a fuel run solenoid. The fuel run solenoid opens a valve which supplies fuel to the injection pump.

When starting in a cold environment, turning the key to a position between run and start for a few moments before starting, will supply current to a thermo start plug in the intake manifold. The plug ignites a fuel-air mixture in the intake manifold to facilitate cold weather starting.

The starting circuit functions as follows:

1. Current from the batteries (1, Fig. 10.7) flows through the positive battery cable (2) to the starter solenoid (3).
2. It then flows to circuit breaker (4) and to terminal “1” of the ignition switch (5).
3. When the key (6) is turned to the START position, current flows through contacts in the ignition switch to the park lock brake switch (7).
4. If the park lock brake is set, current flows through contacts in the brake switch to the neutral start switch (8).
5. If the transmission select lever is in neutral, current flows through contacts in the neutral start switch to energize the coil of the starter relay (9). The relay closes contacts which allow current to energize the starter solenoid (3) and operate the starter.
6. When the solenoid and related mechanisms cause the starter pinion to engage a gear on the flywheel, the starter motor rotates the gear, crankshaft and related components in the engine.
7. When the ignition key was turned in step 3, the fuel run solenoid opened a valve to supply fuel to the fuel injection pump. As the starter rotated the engine components, the fuel injection pump and related lines and injectors supplied fuel to the cylinders.
8. When the pistons compress this injected fuel, ignition occurs, the engine runs and the starter pinion retracts.
9. As the engine runs, it operates an alternator which recharges the battery which was used during the starting cycle.



1. Battery, 12 V
2. Positive Battery Cable
3. Starter Solenoid
4. Circuit Breaker, 40 A
5. Ignition Switch
6. Ignition Key
7. Park Lock Brake Switch
8. Neutral Start Switch
9. Starter Relay
10. Starter
11. Starter Ground Cable
12. Negative Battery Ground Cable
13. Circuit Breakers
14. Brake Light
15. Male Terminal
16. Wire Assembly

Fig. 10.7 Starting Circuit

10. When the ignition key is released after starting, it returns to a neutral position where it directs current to circuit breakers (13) which distribute current for the operation of forklift controls, gauges and equipment.
11. When the ignition key is turned to the OFF position, contacts within the ignition switch are opened and the fuel run solenoid valve closes, blocking the flow of fuel to the fuel injection pump.

10.5.1 Testing Starter in Forklift

General Starter Checks

If nothing happens when you turn the ignition key:

1. The 40 A circuit breaker may be open and require replacement;
2. There may be a defect in the ignition switch, ignition wiring, or starter solenoid;
3. Check the condition of the batteries as described in paragraph 10.6.2. Clean the battery posts and the connectors at each end of the battery cables. Also check the ground cable between the starter mounting bolt and the frame.
4. Check for broken wires and damaged insulation on the wires. Replace all broken or damaged wiring.
5. Check all connections at the starter solenoid, key switch, and wiring harness plugs. Clean and tighten all connections.
6. If the starter still does not run after you do these checks, check the starting circuit.

Starter Circuit Checks–Test 1

1. With the key turned to the RUN position, use a jumper wire to try shorting the positive battery cable to the solenoid starter connection. If the

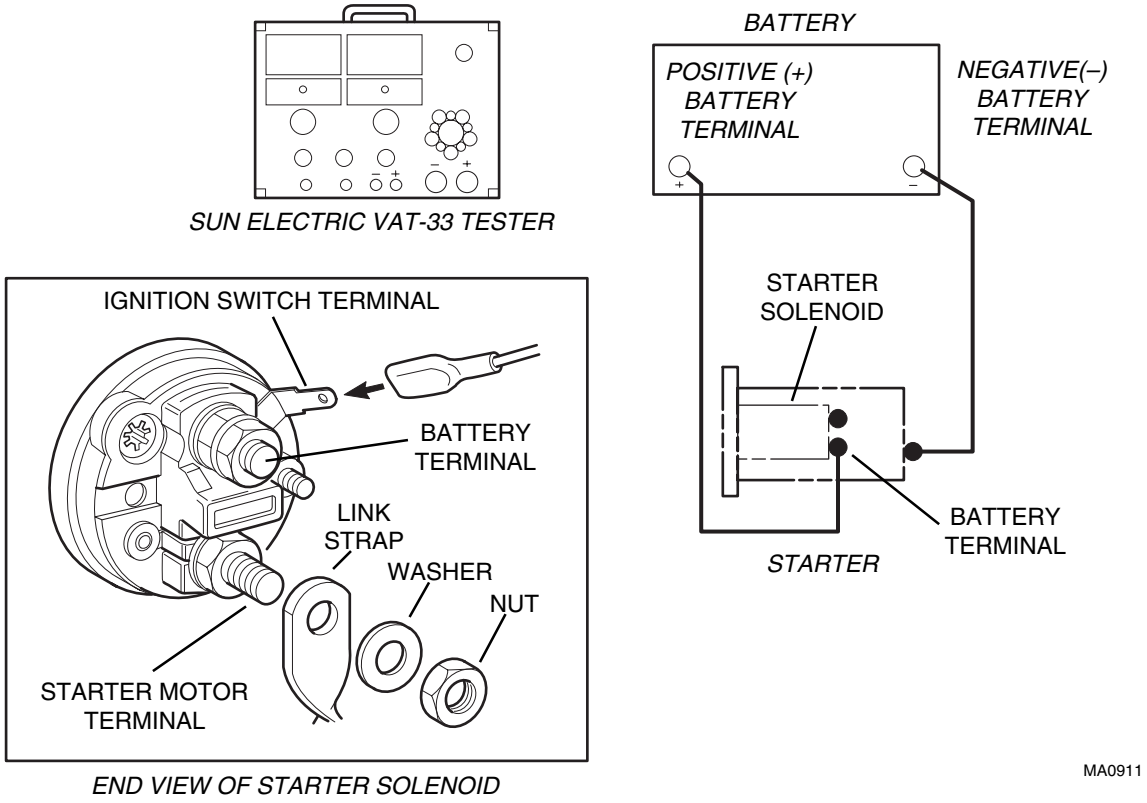


Fig. 10.8 Positive and Negative Battery Cables with End View of Starter Solenoid

starter now cranks, the problem is in the wiring circuit. If the solenoid fails to "click" the starter is probably defective.

2. If you hear a "whirring" noise but the engine does not crank, the starter is spinning but is not engaging the flywheel. The starter drive or solenoid that pushes the drive forward to engage the flywheel may be defective. Missing teeth on the flywheel can also prevent the starter from cranking the engine.
3. If the starter only "clicks", it might indicate discharged batteries or a loose or corroded battery cable connection(s). Check battery charge and condition first.
4. The starter is usually bad if it does nothing at all (even when jumped), if it cranks very sluggishly, or if it makes grinding noises while cranking.

Starter Circuit Checks–Test 2

1. If the forklift is equipped with lighting, switch on the lights. If not, connect a 0-20 Vdc voltmeter across the battery terminals before proceeding. Disconnect the wire from the fuel shut off solenoid at the fuel injection pump. Turn the ignition switch to START and watch for the following symptoms:
   - The lamps dim (or the voltmeter reading drops to about 6 volts, and the starter motor does not crank the engine). Check the batteries (must be at least half-charged) and battery lugs (clean and with a good ground connection).
   - If the lamps do not dim (or the voltmeter reading remains steady at about 12 volts, and the starter does not crank the engine, connect voltmeter between the BAT

solenoid terminal and the starter yoke. Operate the starter.

2. If no volts are indicated, check for:
   - poor lug connections at battery
   - bad ground connection
   - broken starter lead, batteries to starter
3. If full voltage (12 to 14 V) is indicated, check for:
   - Faulty solenoid switch
   - Open circuit in starter (check brushes)
4. Reconnect the wire from the fuel shut off solenoid at the fuel injection pump.

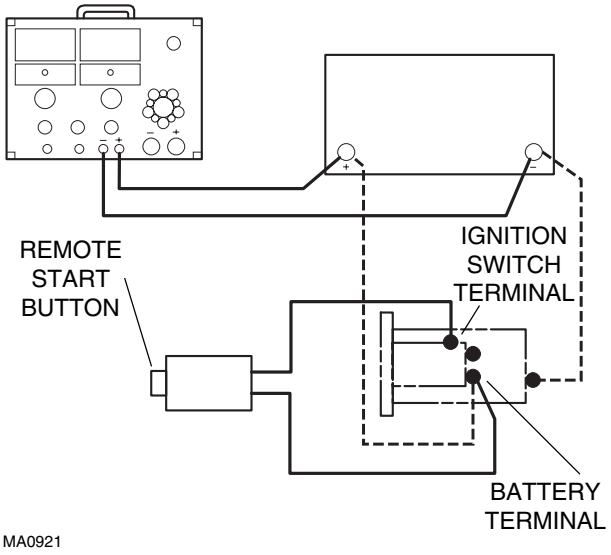


Fig. 10.9 Measuring Voltage Loss in Complete Starting Circuit

10.5.2 How to Check Voltage Loss in the Starting Circuit

- The starter remains on the engine for these tests.
- Do not operate the starter for more than 15 seconds at one time. After the starter has run for 15 seconds, let the starter cool for two minutes before operating the starter again.
- These tests will require a voltmeter.

a. Voltage Specifications

Minimum voltage while starter is running 9.6 V

Maximum voltage loss:
- Positive battery cable and starter solenoid 0.5 V
- Each cable 0.4 V
- Starter solenoid 0.1 V
- Each connection 0.0 V

b. Test 1—Voltage Loss in Complete Starting Circuit

1. Disconnect the wire from the fuel run solenoid (2, Fig. 10.42) at fuel injection pump, Fig. 10.9.
2. Turn ignition key to the ON position.
3. Connect a remote starter button to the battery and ignition switch terminals on the starter solenoid.
4. Select voltage range that will measure 12 Vdc.
5. Move the voltage lead switch on the voltmeter to the EXT position.
6. Connect the positive lead of the voltmeter to the positive battery cable at the battery.
7. Connect the negative lead of the voltmeter to the negative battery cable at the battery.
8. Push in and hold the starter button and read the voltmeter.
   a. If the voltmeter indicated 9.6 V or more, the starting circuit is in good condition and no other testing is required.
   b. If the voltmeter indication was less than 9.6 V, complete Test 2.

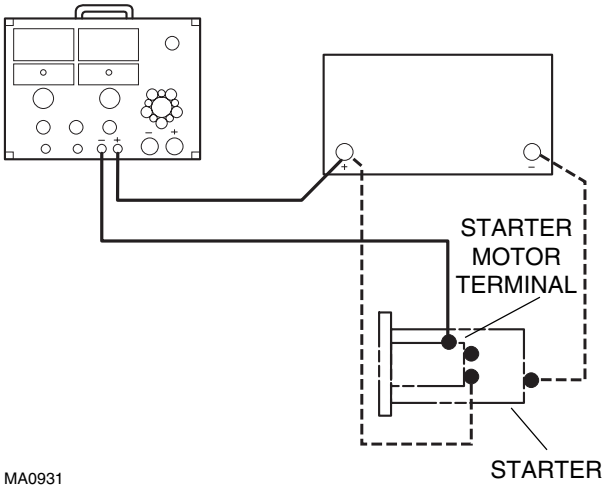


Fig. 10.10 Measuring Voltage Loss in the Positive Battery Cable and Starter Solenoid

c. Test 2—Voltage Loss in the Positive Battery Cable and Starter Solenoid

1. The positive lead of the voltmeter stays connected to positive battery cable, Fig. 10.10.
2. Connect the negative lead of the voltmeter to the starter motor terminal on the starter solenoid.
3. Push in and hold the starter button and select the lowest range for the voltmeter. Read the voltmeter.

4. Select the voltmeter range that will measure 12 V and release the starter button.
5. If the voltage indication was:
   a. 0.5 Vdc or less, complete Test 5.
   b. More than 0.5 V, complete Test 3 and Test 4.

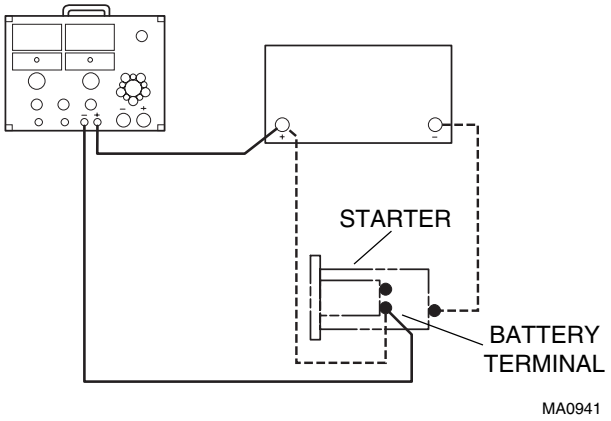


Fig. 10.11 Measuring Voltage Loss in Positive Battery Cable

d. Test 3—Voltage Loss in Positive Battery Cable

1. Positive lead of voltmeter stays connected to the positive battery cable, Fig. 10.11.
2. Select lowest voltage range for the voltmeter.
3. Connect the negative lead of the voltmeter to the battery terminal of the starter solenoid.
4. Push in and hold the starter button, and read the voltmeter.
5. If the voltage indication was:
   a. More than 0.4 V, replace the battery cable.
   b. 0.4 V or less, complete Test 4.

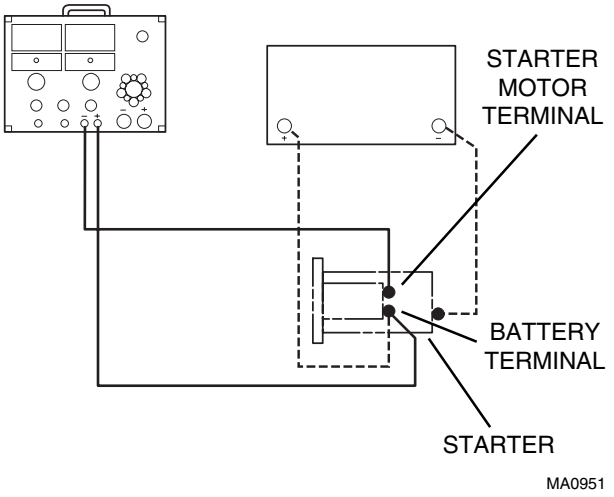


Fig. 10.12 Measuring Voltage Loss in Starter Solenoid

e. Test 4—Voltage Loss in Starter Solenoid

1. Connect the positive lead of the voltmeter to the battery terminal on the starter solenoid, Fig. 10.12.
2. Connect the negative lead of the voltmeter to the motor terminal on the starter solenoid.
3. Select voltage range that will measure 12 Vdc.
4. Push in and hold the starter button and select the lowest voltage range for the voltmeter; read the voltmeter.
5. Select the voltage range that will measure 12 Vdc and release the starter button.
6. If the voltage indication was more than 0.1 V, replace the starter solenoid.

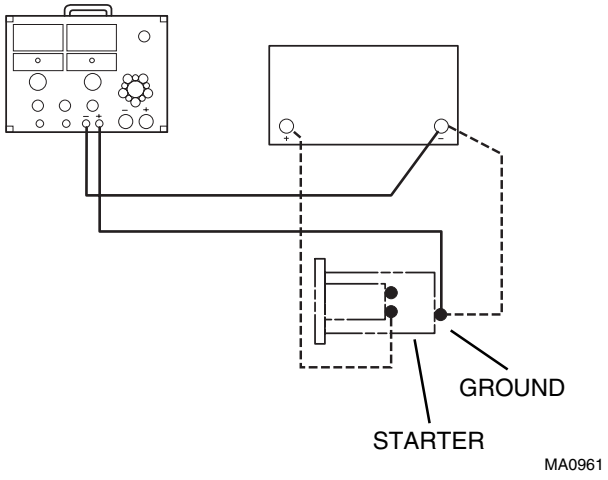
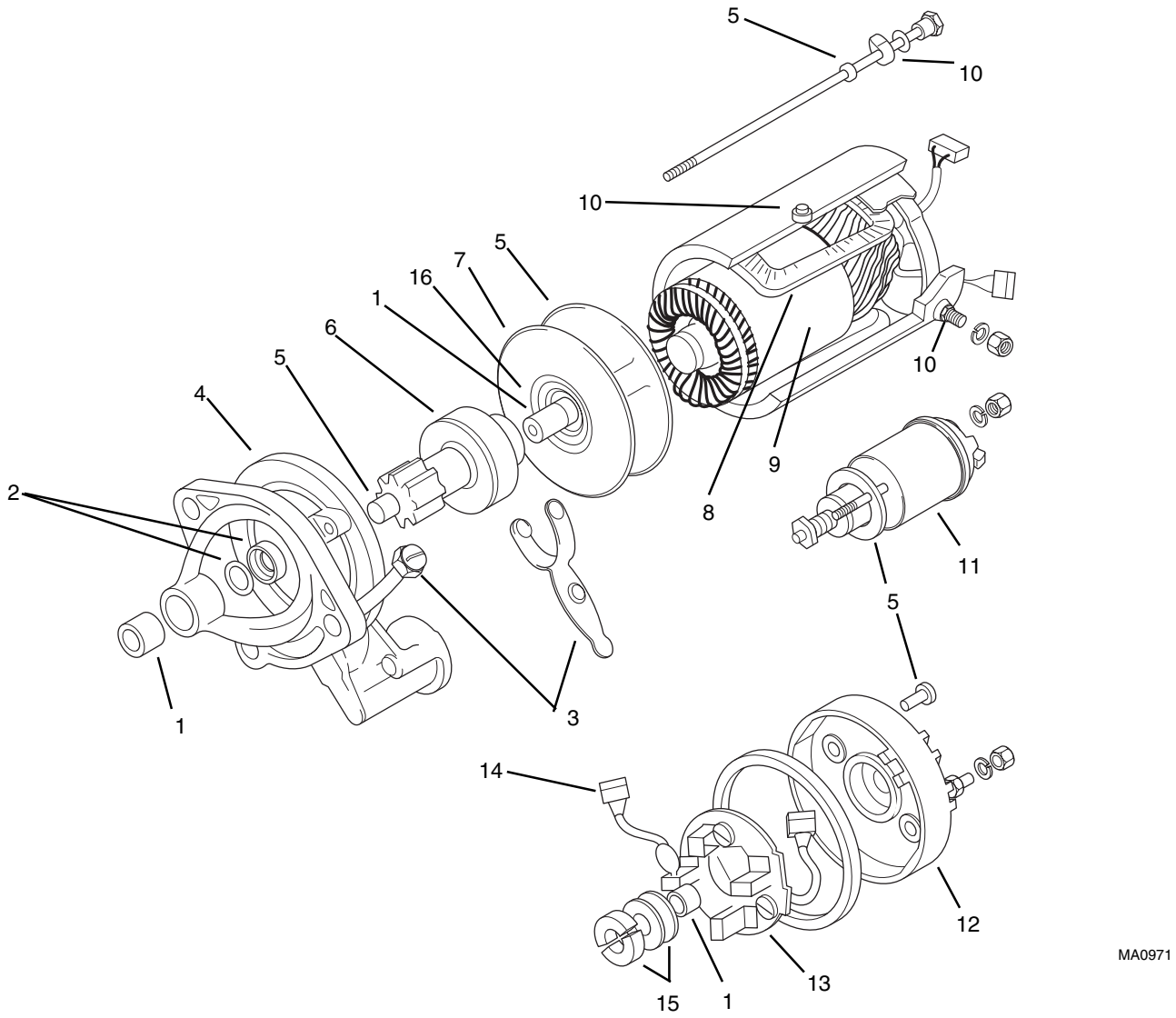


Fig. 10.13 Measuring Voltage Loss in Negative Battery Cable

f. Test 5—Voltage Loss in Negative Battery Cable

1. Connect the negative lead of the voltmeter to the negative battery cable at the batteries, Fig. 10.13.
2. Connect the positive lead of the voltmeter to the negative battery cable at the starter mounting nut.
3. Select lowest voltage range for the voltmeter.
4. Push in and hold the starter button and read the voltmeter.
5. If the voltmeter indication was:
   (a) More than 0.4 V, replace the negative battery cable.
   (b) 0.4 V or less, the negative battery cable is good.



1. Bushing kit
2. Retainer
3. Forked engagement lever
4. Drive end bracket
5. Seal kit
6. Drive pinion assembly
7. Intermediate bracket
8. Field coil
9. Armature
10. Parts kit
11. Solenoid
12. Commutator end bracket
13. Brush kit
14. Brush kit
15. Thrust washer
16. Brake kit

Fig. 10.14 Starter

10.5.3 Starter

The starter is located behind the left access door at the back of the engine. The starter drive engages teeth on the flywheel when cranking the engine.

The starter motor is a four-pole, four brush ground return motor with series-parallel connected field coils. A solenoid-operated pre-engaged drive assembly is mounted on an extension of the armature shaft.

a. Operation

When the ignition key is turned to the start position, a solenoid (11, Fig. 10.14) on the starter motor yoke is energized and actuates a forked engagement lever (3) to energize the drive pinion assembly (6) with the engine flywheel. On occasions of tooth-to-tooth abutment, axial movement of the pinion is arrested while a helically splined sleeve in which the pinion is carried continues to move forward. This causes the pinion to rotate

relative to the flywheel. When the teeth become aligned, spring pressure slides the pinion into mesh with the flywheel.

When the pinion is properly engaged with the flywheel teeth a pair of contacts are closed in the rear of the unit. Closure of the contacts connects the motor to the battery, the armature rotates and the starter pinion cranks the engine.

When the engine fires, the operator returns the ignition key to the run position, the solenoid unit is de-energized and the spring-loaded plunger in the solenoid withdraws the starter pinion to its out-of-mesh position. The armature (9) is brought rapidly to rest by the centrifugal action of a pair of spring-loaded brake shoes (16) bearing against a brake drum inside the intermediate bracket (7).

If the pinion jams in mesh (this may occur with an engine which fails to start) there is sufficient slack in the engagement lever-to-solenoid plunger linkage to permit the solenoid switch contacts to open.

If the drive remains in mesh with the flywheel after the engine has run up to speed, the starter motor armature is protected from over speeding by the plate clutch assembly. This clutch allows torque to be transmitted from the starter motor to the engine but not from the engine to the starter motor.

The clutch is set to slip at between two and three times normal starting torque, thus providing overload protection for the starter motor.

b. Removal

Remove the starter only if it fails the tests listed in paragraph 10.5.2. To remove the starter:

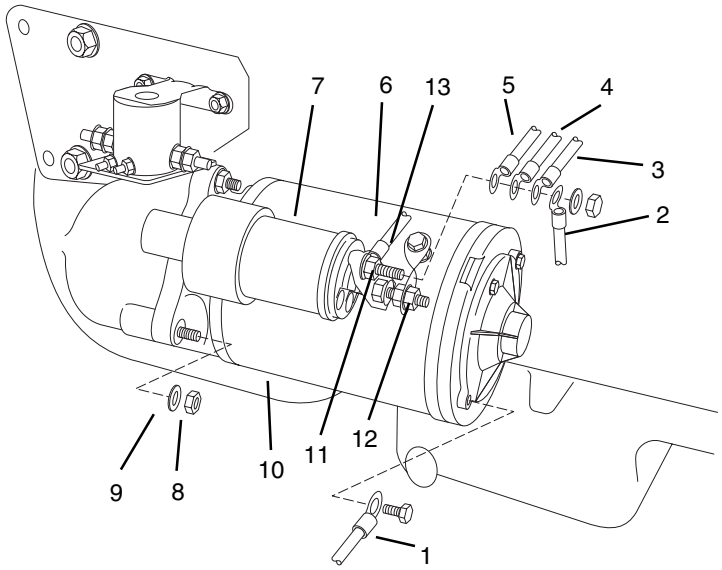
1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Tag and disconnect the negative ground cable (1, Fig. 10.15) from the starter.
3. Tag and disconnect the positive cable (2) and other wiring (3, 4, 5 and 6) from the starter solenoid (7), paying attention to the sequence in which the wires are installed on the terminal.
4. Loosen but do not remove the three hex nuts (8) that secure the starter to the flywheel housing. Be careful when you remove the nuts because the starter is heavy and it will fall if not supported. Using one hand to support the starter, remove the nuts (8) and lock washers (9) and lift the starter (10) from the forklift.

c. Disassembly

Disassemble starter only as required by the periodic maintenance recommendations in paragraph h.

d. Cleaning and Drying

1. While the starter is out wipe away any grease or dirt that has accumulated around the starter hole.



1. Starter negative ground cable
2. Positive cable
3. Wire 29
4. Wire 27
5. Wire 5
6. Wire 19
7. Starter solenoid
8. Hex nuts
9. Lock washers
10. Starter
11. Battery terminal
12. Starter motor terminal
13. Ignition switch terminal

Fig. 10.15 Starter Removal

2. If the starter is to be reinstalled, clean the exterior of the starter with an approved solvent without submerging the starter or allowing the solvent to contact the bushings.
3. Dry the starter using a clean, lint-free cloth.

e. Inspection and Replacement

You can bench test a starter by using battery jumper cables. Connect the negative cable to the starter housing and touch the positive cable to the positive connection on the starter motor. The motor should spin if it is good.

f. Starter No Load Test

General Information

1. The No Load Test is done with the starter removed from the forklift.
2. If the starter drive doesn't slide freely on the armature shaft, clean and repair as required.
3. If the armature doesn't rotate freely, disassemble the starter and repair as required before doing the No Load Test.

Test Equipment

1. A Sun Electric VAT-33 Tester, an equivalent tester, or separate pieces of test equipment.
2. A hand held tachometer.
3. A remote starter button to actuate the starter.
4. A fully charged 12 V battery.

Test Procedure

Connect the test equipment according to this procedure and the manufacturer's instructions. If the VAT-33 tester is being used:

1. Select the 0 to 100 A range.
2. Select the 18 to 40 V range.
3. Move the volt lead switch to the EXT position.
4. Turn the load control to the OFF position.

Warning !

Fasten the starter in a vise or use another method to prevent the starter from moving; this is essential to prevent personal injury.

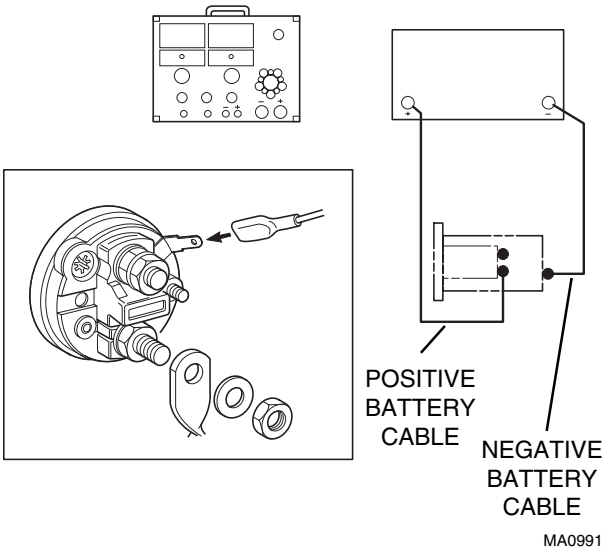


Fig. 10.16 Positive and Negative Battery Cables with End View of Starter Solenoid

5. Connect the positive battery cable to the battery terminal on the starter solenoid and the negative battery cable to the mounting flange of the starter, Fig. 10.16.

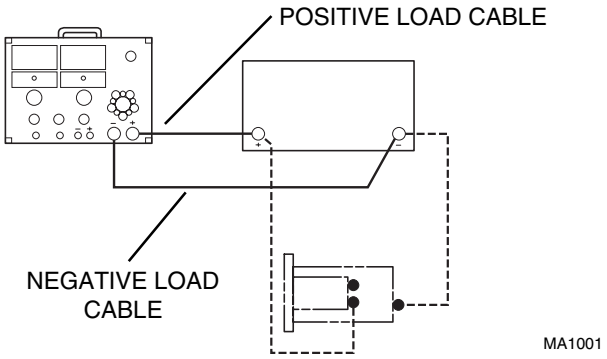


Fig. 10.17 Positive and Negative Load Cables

6. Connect the positive load cable to the positive post of the battery. Connect the negative load cable to the negative post, Fig. 10.17.

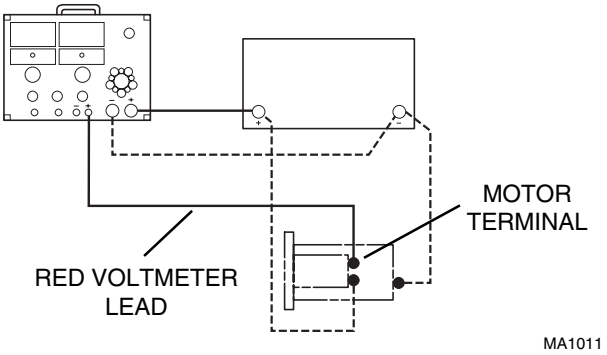


Fig. 10.18 Red Voltmeter Lead

7. Connect the red voltmeter lead to the motor terminal on the starter solenoid, Fig. 10.18.

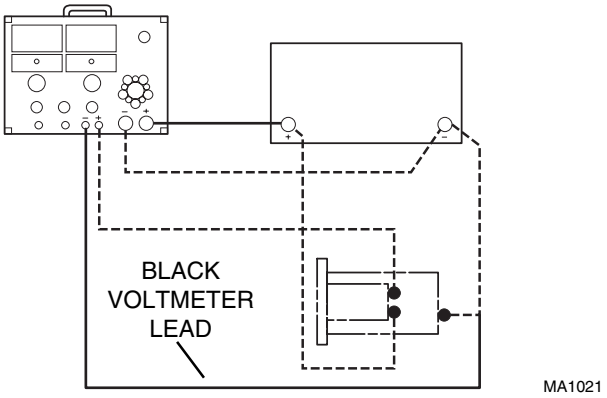


Fig. 10.19 Black Voltmeter Lead

8. Connect the black voltmeter lead to the mounting flange on the starter, Fig. 10.19.

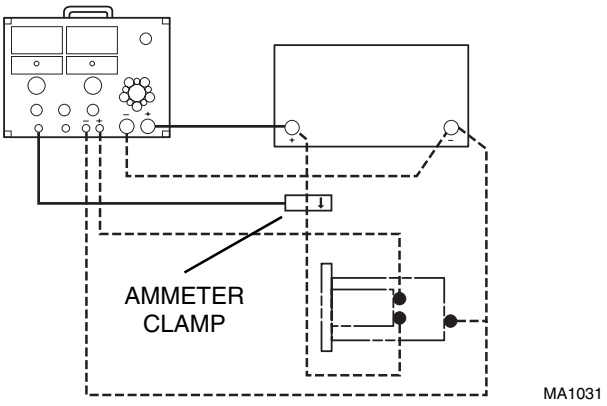


Fig. 10.20 Ammeter Clamp

9. Fasten the ammeter clamp around the positive battery cable so that the tip of the arrow is toward the starter, Fig 10.20.

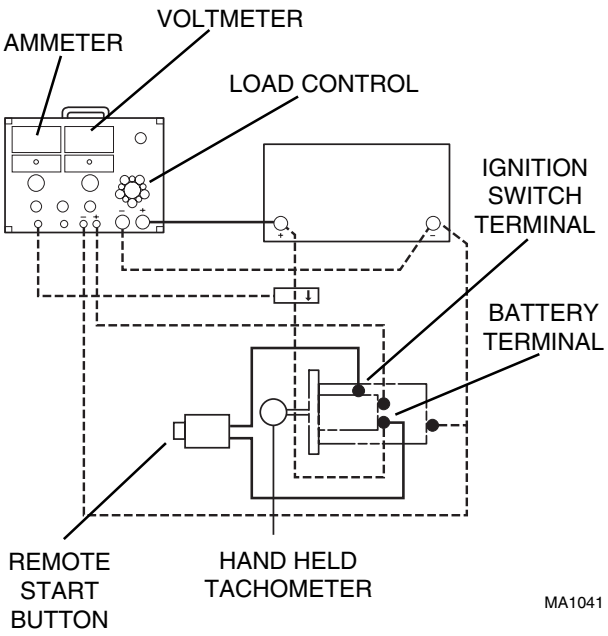


Fig. 10.21 Remote Start Button and Hand Held Tachometer

10. Connect the leads from the remote starter button to the Battery and Switch terminals, Fig. 10.21.

IMPORTANT: *Steps 11, 12, and 13 must be done rapidly. Do not load the battery for more than 15 seconds at one time. After the battery has been loaded for 15 seconds, let the starter cool for 60 seconds.*

11. Actuate the starter and turn the load control until the voltmeter indicates 11 volts.
12. Look at the ammeter and make a record of the ammeter indication.
13. Use the hand held tachometer, Fig. 10.21, and check the armature shaft speed. Make a record of armature shaft speed.
14. Release the remote starter button and turn the load control to the OFF position.
15. If the current draw and the armature shaft speed are within the ranges under Specifications, the starter is good.
16. Low armature shaft speed and high current draw are indications of too much friction. Possible causes of too much friction are:
    (a) Tight, dirty, or worn bearings.
    (b) A bent armature shaft.
    (c) Loose pole shoes (pole shoes make contact with the armature).
    (d) A short circuit in the armature coil. Disassemble the starter. Use an armature tester to test the armature. Use the instructions included with the armature tester.
    (e) Damaged field coil. Do the tests described in paragraph g.
17. If the armature does not rotate and the current draw is high, possible causes are:
    (a) Field terminal making contact with the field frame. Inspect the insulators for the field terminal.
    (b) Damaged field coil. Do the tests described in paragraph g.
    (c) Damaged bearings.
18. If the armature does not rotate and the current draw is zero, possible causes are:
    (a) An open field circuit. Disassemble the starter and inspect field coil connections.
    (b) An open armature coil. Disassemble the starter and check for burned commutator

bars. Use an armature tester to test the armature. Use instructions included with the armature tester.

(c) Brushes are not making good contact with the commutator bars. Check for high insulation between the commutator bars, broken brush springs, or worn brushes.

19. Low armature shaft speed and low current draw are indications of:

(a) Dirt or corrosion on connections

(b) Damaged wiring.

(c) Dirty commutator bars.

(d) All of the causes in step 18.

20. High armature shaft speed and high current draw are indications of a short circuit in the field coil. It is difficult to find a short circuit in a field coil. Install a new field coil. Do the No Load Test again to check for improvement in the operation of the starter.

g. Starter Field Coil Tests

1. Hold the leads of an ohmmeter against one of the brushes and the frame of the field coil. The needle of the ohmmeter **must not move**. If the needle moved, install a new field frame assembly.

2. Hold the leads of an ohmmeter against one of the brushes and the end of the negative ground cable. The needle of the ohmmeter **must move**. If the needle did not move, install a new field coil frame assembly.

h. Periodic Maintenance

The starter motor requires no routine maintenance beyond the occasional inspection of the electrical connections which must be clean and tight, brush wear and the commutator.

After the starter motor has been in service for some time, remove the starter motor from the engine and submit it to a thorough bench inspection by qualified personnel.

1. Brush wear is a fair indication of the amount of work done by the starter. Replace brushes when length approaches 5/16" (7,9 mm).

2. Brush spring tension. Correct tension is 30 to 40 oz (0,85 to 1,13 kg). Replace springs if tension has dropped below 25 oz (0,71 kg).

3. Turn commutator if it is pitted or badly worn.

4. Check bearings for excessive side play of armature shaft.

5. Check pinion movement.

6. Clean and lubricate the indented bearing inside the pinion sleeve using Shell SB2628 grease for temperate and cold climates and Shell Retinex for hot climates.

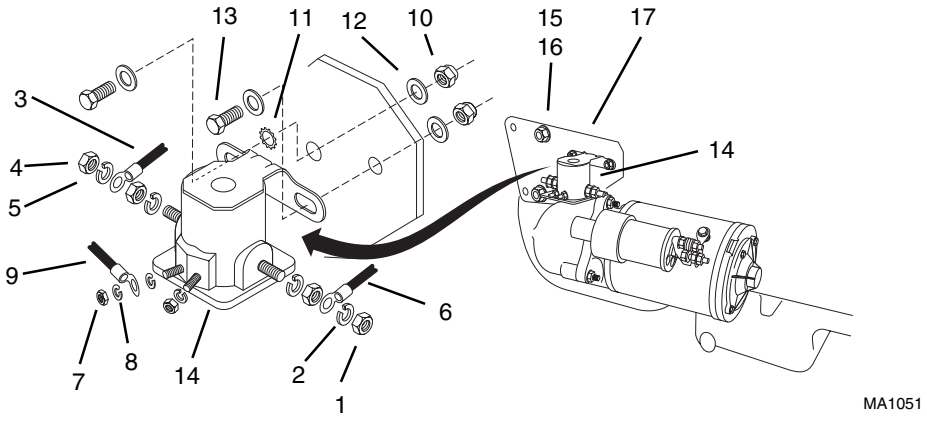
7. Clean and lubricate the indented bronze bearing in the intermediate bracket. Use Ragosine “Molypad” Molybdenised non-creep oil for this purpose.

i. Installation

1. Position the starter on the flywheel housing, install three lock washers (9, Fig 10.15) and three nuts (8), and torque the nuts to 3.4 lb-ft (4,6N m).

2. Connect the wires (3 through 6) to the starter solenoid (7).

3. Connect the positive (+) battery cable (2) to the starter.



1. Hex Nut
2. Lock Washer
3. Battery Positive Lead Cable
4. Hex Nut
5. Lock Washer
6. Starting Motor Feed Cable
7 Hex Nut
8. Lock Washer
9. Terminal “S” from Neutral Start Switch
10. Self-locking Hex Hut
11. Tooth Type Lock Washer
12. Flat Washer
13. Capscrew, hex hd
14. Starting Motor Relay
15. Capscrew
16. Lock Washer
17. Relay Mounting Plate

Fig. 10.22 Starting Motor Relay

4. Connect the positive (+) cable (2) to the positive terminals on the batteries.
5. Connect the negative (–) cable (1) to the negative terminals on the batteries.
6. Connect the ground cable (1) to the starter.

10.5.4 Starting Motor Relay

The starting motor relay, Fig. 10.22, consists of a movable contact with a fixed coil in a weatherproof casing.

The relay is internally grounded and is equipped with two large and two small terminals. The small terminal “S” is for connection to the ignition system resistance wire. The two large terminals are for connection between the batteries and the starting motor.

Turning the ignition switch, with the transmission in neutral, allows current to flow through the relay coil via terminal “S” to the ground point on the casing. The flow of current energizes the coil forming a magnetic field which attracts a movable contact. When the contacts fully close, current from the batteries is allowed to flow to the starting motor through the relay.

Once the key switch is released, the flow of current to the coil is stopped thereby breaking the magnetic field and allowing the return spring to open the contacts. This action stops the current flow from the batteries to the starting motor.

a. Removal of Starting Motor Relay and Relay Mounting Plate

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Disconnect positive (+) battery cable (3, Fig. 10.22) by removing hex nut (4) and lock washer (5).
3. Disconnect starting motor feed cable (6) by removing hex nut (1) and lock washer (2).
4. Disconnect neutral start switch connector (9) from terminal “S” from by removing hex nut (7) and lock washer (8).
5. Remove starting motor relay (14) from relay mounting plate (17) by removing two self-locking hex nuts (10) and flat washers (12) from behind plate. On the left side of the starter motor relay, remove a tooth-type lock washer (11) from between the plate and the starter relay. Then remove capscrews (13).
6. If necessary, remove relay mounting plate (17) by removing two capscrews (15) and two flat washers (16).

b. Disassembly of Starting Motor Relay

IMPORTANT: *Do not disassemble starting motor relay; service only as a complete assembly.*

c. Cleaning and Drying

Without submerging the starting motor relay, clean the relay using an approved solvent and dry with a clean cloth.

d. Inspection and Replacement

1. Test the operation of the relay by connecting a 12 Vdc positive source to terminal “S” and the negative lead to the mounting bracket; replace the relay if you don’t hear the contacts close.
2. Inspect the general condition of the casing and terminals and replace the relay if damaged.

e. Installation

1. If it was removed, position the relay mounting plate (17, Fig. 10.22) on the engine and secure it with two capscrews (15) and two lock washers (16). Use Loctite® 222 on the capscrews.
2. Install capscrew (13) through flat washer (12) and the LEFT hole in the relay bracket. Place a tooth-type lock washer (11) over the end of the capscrew. Insert end of screw through relay mounting plate (17) and secure the screw with a flat washer (12) and a lock nut (10). Repeat this installation through the right hole in the relay bracket but without using a tooth type lock washer between the relay bracket and the relay mounting plate.
4. Install connector “S” from neutral start switch terminal (9) by installing lock washer (8) and hex nut (7).
5. Connect starting motor feed cable (6) by installing lock washer (2) and hex nut (1).
6. Connect positive (+) battery cable (3) by installing lock washer (5) and hex nut (4).

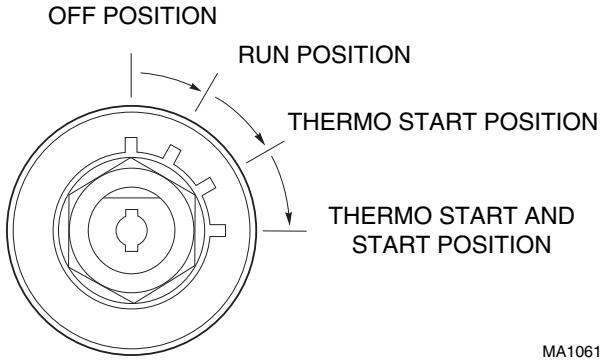
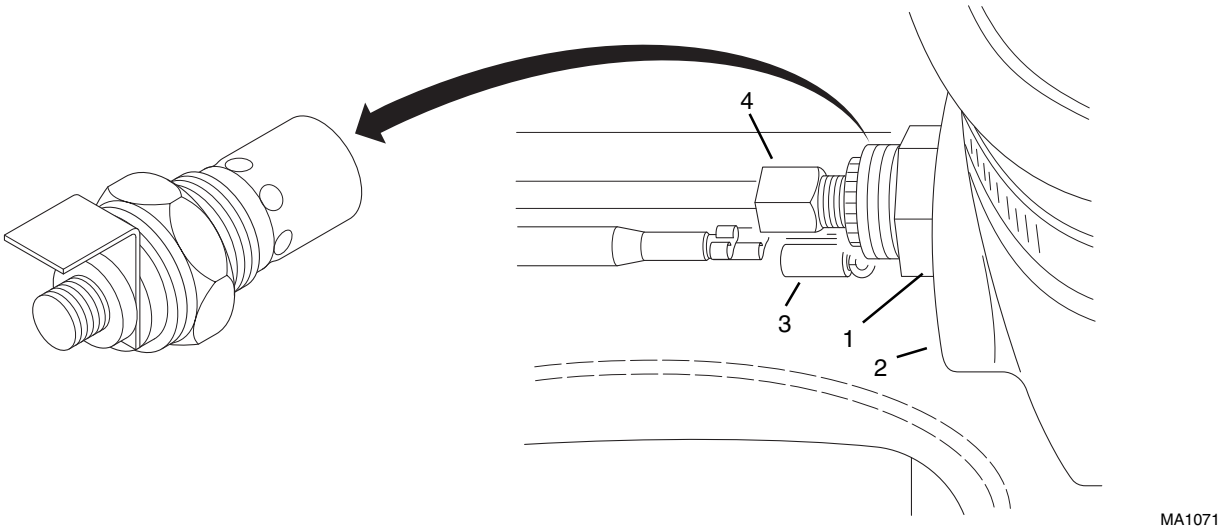


Fig. 10.23 Ignition Key Switch



1. Thermo Start Plug 2. Intake Manifold 3. Electrical Terminal 4. Fuel Line Fitting

Fig. 10.24 Thermo Start Plug for Cold Weather Starting

10.5.5 Thermo Start Plug for Cold Weather Starting

When the ignition key switch, Fig. 10.23, is turned to the Thermo Start position, a Thermo Start plug (1, Fig. 10.24) ignites a fuel/air mixture in the intake manifold (2) to facilitate cold weather starting.

To use this starting aid for cold weather starting, turn key to the Thermo Start position and hold it there for fifteen to twenty seconds. With the throttle pedal fully depressed, turn the key to the START position to engage the starter motor.

If the engine doesn't start within fifteen seconds, return the switch to the THERMO START position for ten seconds and then reengage the starter motor by turning key to the START position.

As soon as the engine starts, allow key to return to the RUN position.

If the engine should fail to start, check the electrical connection to the Thermo Start plug.

In the event of difficult starting, check that fuel is reaching the Thermo Start plug by unscrewing the inlet fuel connection. If fuel is reaching the Thermo Start plug, the plug itself may not be working correctly. This can be checked by removing the air cleaner and watching the cold starting aid while the equipment is used. When the starting switch is turned to the THERMO START position, the element should become red hot, and on engagement of the starter motor, ignition of the fuel should take place.

The engine is fitted with an efficient cold starting aid and no responsibility can be accepted for any damage caused by unauthorized starting aids.

a. Removal

1. Tag and disconnect wire at electrical terminal (3, Fig. 10.24).
2. Disconnect fuel line (4).
3. Remove Thermo Start plug.

b. Disassembly

Do not disassemble the Thermo Start plug.

c. Cleaning and Drying

Without submerging the Thermo Start plug, clean the exterior of the plug in an approved solvent and dry using a clean lint-free cloth.

d. Inspection and Replacement

1. Examine the bore of the fuel channel for any contamination and clean as required.
2. Test the coil of the Thermo Start plug using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply. If the coil doesn't heat, replace the Thermo Start plug.

e. Installation

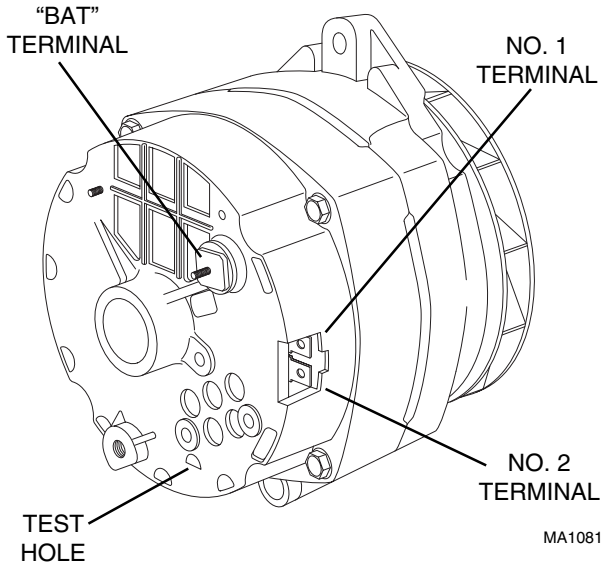
1. Install the Thermo Start plug.
2. Connect fuel line (4, Fig. 10.24).
3. Connect wire at electrical terminal (3).

10.6 CHARGING CIRCUIT

The charging circuit, Fig. 10.26, is described in paragraph 10.6.1.a.

10.6.1 Alternator

The alternator, Fig. 10.25, has a rotating field system inside a stationary generating winding. When the rotor rotates inside the stator, the output produced is alternating current (ac). This is unsuitable for charging the battery which requires direct current (dc), so it is rectified by means of diodes which convert it to unidirectional flow to the battery.



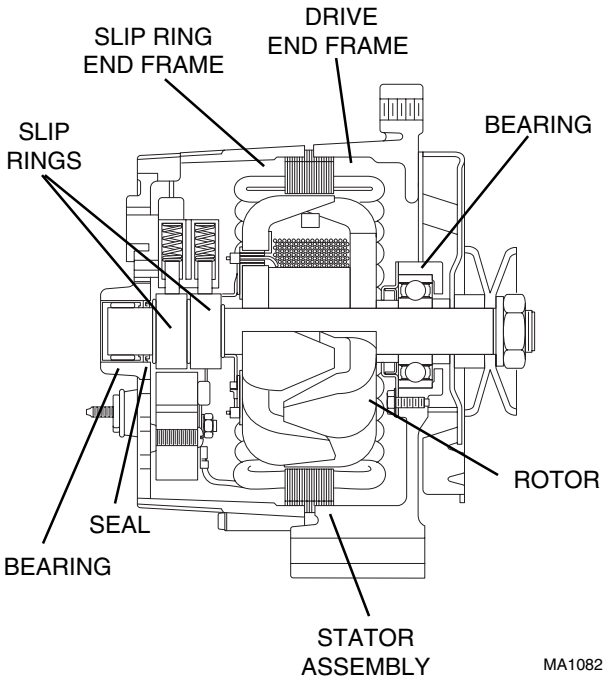


Fig. 10.25 Typical 12-SI Series Alternator

The alternator has a solid state regulator that is mounted inside the alternator slip ring end frame. The regulator voltage setting never needs adjusting, and no provision for adjustment is provided.

The alternator rotor bearings contain sufficient lubricant to eliminate the need for periodic lubrication. Two brushes carry current through two slip rings to the field coil mounted on the rotor, and under normal conditions will provide long periods of attention-free service.

The stator windings are assembled on the inside of a laminated core that forms part of the alternator frame. A rectifier bridge connected to the stator windings contains six diodes, and electrically changes the stator ac voltages to a dc voltage which appears at the alternator output terminal. Alternator field current is supplied through a diode trio which also is connected to the stator windings. A capacitor, or condenser, mounted in the end frame protects the rectifier bridge and diode trio from high voltages, and suppresses radio noise.

No periodic adjustments or maintenance of any kind are required on the entire alternator assembly.

a. Charging Circuit Operating Principles

In Fig. 10.26, TERMINAL NO. 2 of the alternator is connected to the battery and the base-emitter of transistors TR3 and TR1 is connected to the battery through resistor R5, thus turning these transistors on. Also, resistors R2 and R3 are connected to the battery through TERMINAL NO. 2, but the discharge current of the battery is very low because of the resistance values of R2, R3, R5, TR1 and TR3.

When the ignition switch is closed, current from the battery flows through the indicator lamp to alternator TERMINAL NO. 1, through resistor R1, and transistors TR3 and TR1 to ground, and then back to the battery. Also, current flows through the alternator field coil and TR2 back to the battery. The indicator lamp then turns on. Resistor R6 carries some of the indicator lamp current.

With the alternator operating, ac voltages are generated in the stator windings, and the stator supplies dc field current through the diode trio, the field coil, TR1, and then through the grounded diodes in the rectifier bridge back to the stator. Also, the six diodes in the rectifier bridge change the stator ac voltages to a dc voltage which appears between ground and the alternator "BAT" terminal.

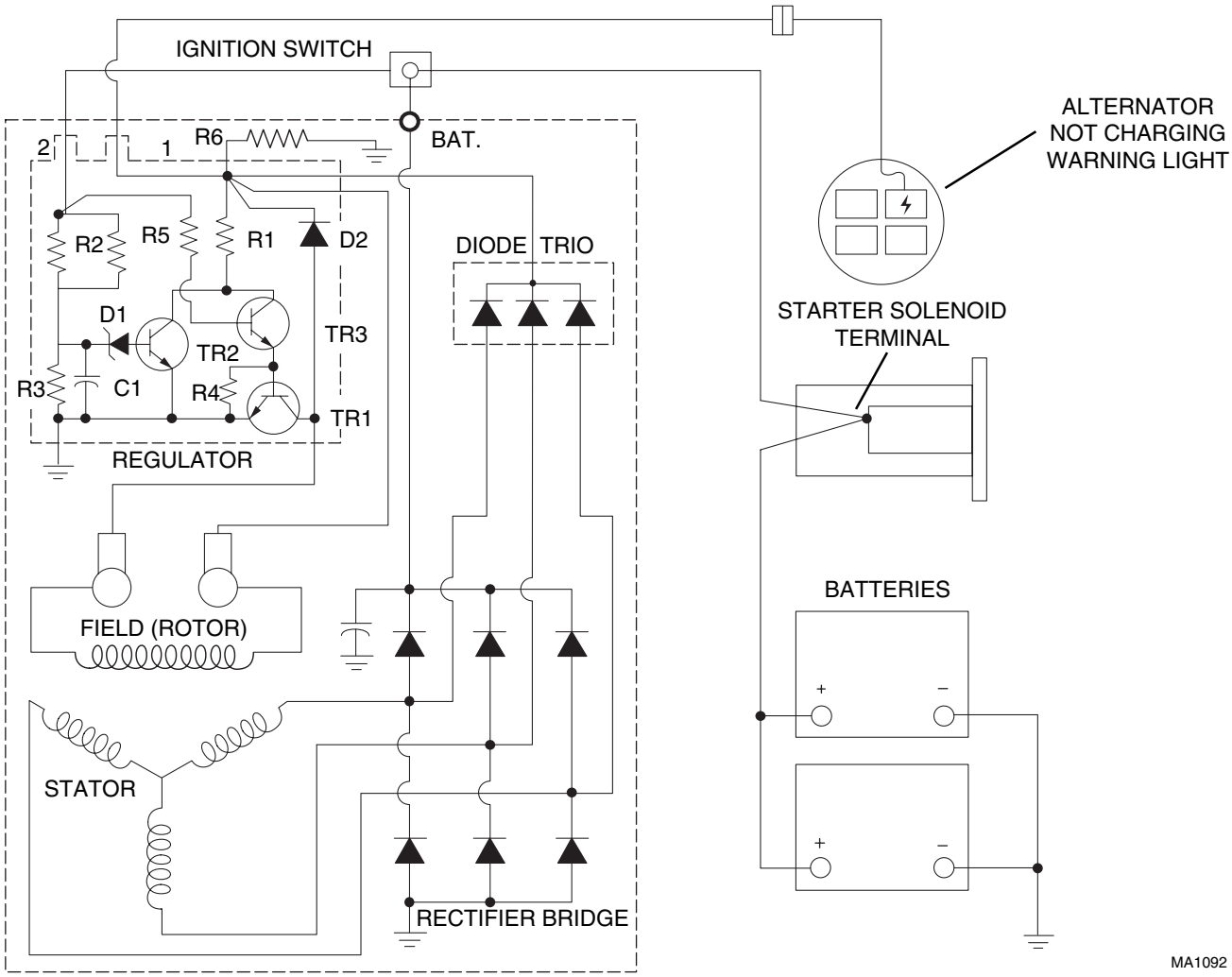


Fig. 10.26 Charging Circuit Showing Internal Circuits of a Typical 12-SI Alternator

As alternator speed increases, current is provided for charging the battery and operating electrical accessories. Also, with the alternator operating, the same voltage appears at the “BAT” and No. 1 terminals, and the indicator lamp goes out to indicate the alternator is producing voltage.

If an open should occur in the TERMINAL NO. 2 circuit, TR3 and TR1 will turn off, no field current will flow to prevent overcharge, and indicator lamp current will flow to a ground through R6 to indicate a defect. Also, an open in the field circuit will cause the indicator lamp to turn on through R6. As the alternator speed and voltage increase, the voltage between R2 and R3 increases to the point where zener diode D1 conducts current. Transistor TR2 then turns on and TR3 and TR1 turn off. With TR1 off, the field current and system voltage decrease, and D1 then blocks current flow, causing TR3 and TR1 to turn back on. The field current and system voltage increase, and this cycle then repeats many times per second to limit the alternator voltage to a preset value.

Capacitor C1 smooths out the voltage across R3, resistor R4 prevents excessive current through TR1 at high temperatures, and diode D2 prevents high-induced-voltages in the field windings when TR1 turns off. Resistor R2 is a thermistor which causes the regulated voltage to vary with the temperature, thus providing optimum voltage for charging the battery.

b. Troubleshooting Procedures

Close adherence to the following procedures in the order presented will lead to the location and correction of charging system defects in the shortest possible time. Only a portion of these procedures need to be performed. It will never be necessary to perform all the procedures in order to locate the trouble.

Either of two methods may be used to troubleshoot the charging system. One method uses alternator tester Model J-26290 available from the Kent-Moore Corporation, Tool Division, 29784 Little Mack, Roseville, MI 48066

The other method follows:

A basic wiring diagram showing lead connections is shown in Fig. 10.26. To avoid damage to the electrical equipment, always observe the following precautions:

- Do not polarize the alternator.
- Do not short across or ground any of the terminals in the charging circuit, except as specifically instructed herein.
- Make sure the alternator and batteries have the same ground polarity.
- When connecting a charger or a booster battery to the forklift batteries, connect negative to negative and positive to positive. The correct jump start procedure is covered in paragraph 10.6.2.g.

Trouble in the charging system will show up as one or more of the following conditions:

A. Abnormal indicator lamp operation.

B. Abnormal charging system operation.

A. Abnormal Indicator Lamp Operation.

Check the indicator lamp on the control console for normal operation as shown below:

Ignition Switch	Lamp	Engine
OFF	OFF	STOPPED
ON	ON	STOPPED
ON	OFF	RUNNING

If indicator lamp operates normally, proceed to "B. ABNORMAL CHARGING SYSTEM OPERATION." Otherwise, proceed to either one of the following three abnormal conditions.

1. Switch Off, Lamp On. In this case, disconnect the two leads from the alternator No. 1 and No. 2 terminals. If the lamp stays on, there is a short between these two leads. If the lamp goes out, replace the rectifier bridge as covered in paragraph 10.6.1.g. This condition will cause an undercharged battery.
2. Switch On, Lamp Off, Engine Stopped. This condition can be caused by the defects listed in step 1 above, or by an open wire in the circuit. To determine where an open exists, proceed as follows:
   (a) Check for an open circuit breaker, a burned out bulb, defective bulb socket, or an open in No. 1 lead circuit between alternator and ignition switch.
   (b) If no defects have been found, proceed to "B. ABNORMAL CHARGING SYSTEM OPERATION."
3. Switch On, Lamp On, Engine Running. Check for an open circuit breaker between indicator lamp and switch. Other possibilities are covered in "B. ABNORMAL CHARGING SYSTEM OPERATION".

If a defect has been found and corrected at this point, no further checks need be made.

B. Abnormal Charging System Operation

1. Check that discharged batteries weren't caused by accessories left ON for extended periods.
2. Check alternator drive belt for proper slack adjustment.
3. If a battery defect is suspected, refer to Section 10.6.2 Battery.
4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the alternator and connections at the batteries.
5. With ignition switch ON and all wiring harness leads connected, connect a voltmeter from:
   (a) Alternator BAT TERMINAL to ground.
   (b) Alternator NO. 1 TERMINAL to ground.
   (c) Alternator NO. 2 TERMINAL to ground.

A zero reading indicates an open between voltmeter connection and batteries. Repair wiring harness if required.

6. With all accessories turned off, connect a voltmeter across the batteries. Operate engine at moderate speed. If voltage is 15.5 V or more on a 12 V system, remove alternator for repair.

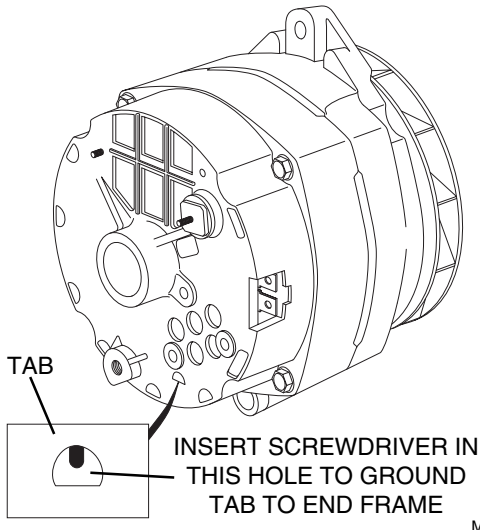
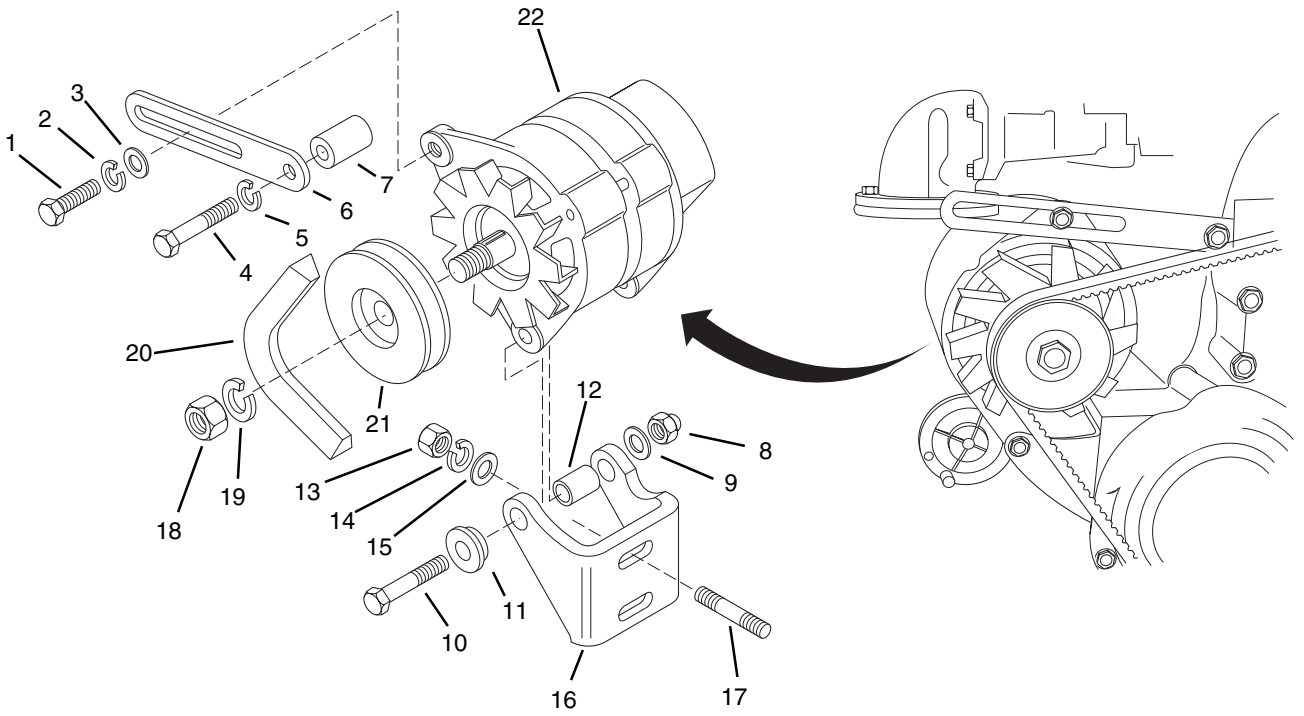


Fig. 10.27 Grounding Alternator Field Winding
(Wiring Connections Are Not Shown)



1.	Screw	4.	Bolt	8.	Self-locking Nut	12.	Sleeve	16.	Bracket	20.	Belt
2.	Lock Washer	5.	Lock Washer	9.	Washer	13.	Nut	17.	Stud	21.	Pulley
3.	Washer	6.	Lever	10.	Screw	14.	Washer	18.	Hex Nut	22.	Alternator
		7.	Spacer	11.	Sleeve	15.	Washer	19.	Washer		

Fig. 10.28 Alternator Removal

7. If previous Steps 1 thru 6 check satisfactory, check alternator as follows:

   (a) Disconnect battery ground cable.

   (b) Connect an ammeter in the circuit at the "BAT" terminal of the alternator.

   (c) Connect battery ground cable.

   (d) Turn on all electric equipment. Connect a carbon pile battery tester across the batteries.

   (e) Operate engine at moderate speed as required, and adjust carbon pile as required to obtain maximum current output.

   (f) If ampere output is within 10 amperes of rated output as stamped on alternator frame, alternator most likely is not defective; recheck Steps 1 thru 6.

IMPORTANT: *If output in amperes is OK, but indicator lamp stays on, check diode trio and rectifier bridge in paragraph 10.6.1.f and 10.6.1.g.*

   (g) If ampere output is not within 10 amperes of rated output, determine if test hole, Fig. 10.27, is accessible. If accessible go to Step h. If not go to paragraph l.

   (h) Ground the field winding by inserting a screwdriver into the test hole, Fig. 10.27.

IMPORTANT: *Tab is within 3/4 inch of casting surface. Do not force screwdriver deeper than one inch into end frame.*

   (i) Operate engine at moderate speed as required, and adjust carbon pile as required to obtain maximum current output.

   (j) If output is within 10 amperes of rated output, check field winding as covered in paragraph 10.6.1.e, and test regulator with an approved regulator tester.

   (k) If output is not within 10 amperes of rated output, check the field winding, diode trio, rectifier bridge, and stator as covered in paragraphs 10.6.1.e, f, g and h.

c. Alternator Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from batteries.
2. Remove screw (1, Fig. 10.28), lock washer (2), and washer (3) from tapped hole in alternator.
3. Remove screw (4), lock washer (5), lever (6), and spacer (7) from tapped hole in engine.
4. While supporting the weight of the alternator (22), remove self-locking nut (8), washer (9), screw (10), sleeve (11), and sleeve (12); lift the alternator from the forklift and carry it to a clean work bench.
5. If necessary, remove hex nuts (13), washers (14), washers (15), bracket (16), and stud (17).
6. If necessary, remove hex nut (18), washer (19), belt (20), and pulley (21).

d. Alternator Disassembly

1. Remove the four thru-bolts and pry alternator apart with a screwdriver at the stator slot.
2. After disassembly, place a piece of tape over the slip ring end frame bearing to prevent entry of dirt and other foreign material, and also place a piece of tape over the shaft on the slip ring end.
3. If brushes are to be reused, clean with a soft dry cloth.
4. To remove the drive end frame from the rotor, place the rotor in a vise and tighten only enough to permit removal of the shaft nut (18, Fig. 10.28).

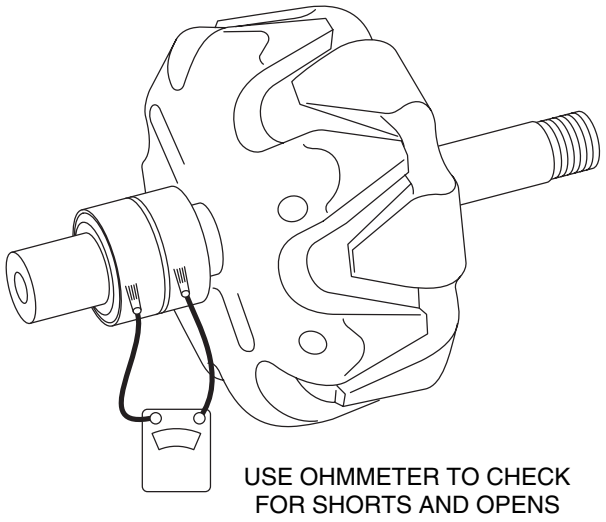


Fig. 10.29 Checking Rotor Winding

e. Rotor Field Winding Checks

1. To check for opens, connect the test lamp or ohmmeter to each slip ring (refer to Fig. 10.29). If the lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open.
2. Connect test lamp or ohmmeter from one slip ring to shaft. If lamp lights, or if reading is low, the rotor winding is grounded (not illustrated).

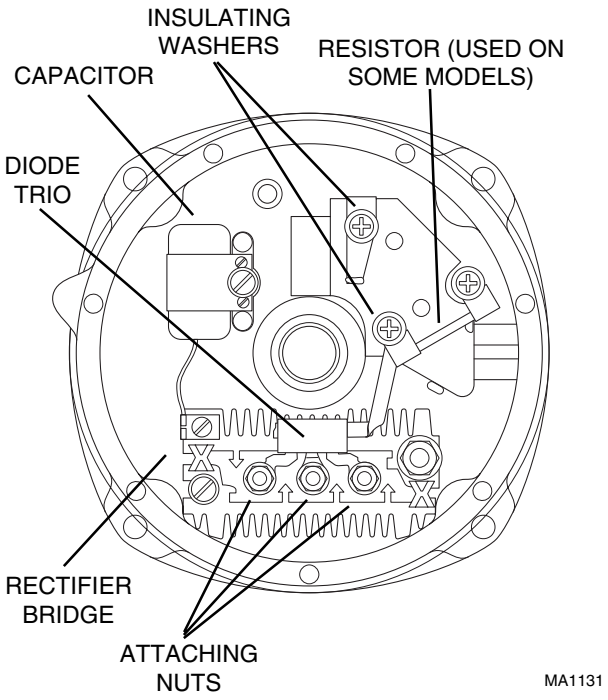


Fig. 10.30 Inside View of 10-SI End Frame Assembly
(12 SI Is Similar)

3. Check the winding for short-circuits or excessive resistance by connecting a battery and ammeter in series with the edges of the two slip rings. The field current ammeter reading at 80 °F (26.7 °C) should be 4.2 to 5.0 A. A reading above this range indicates shorted windings; a reading below this range indicates excessive resistance. An alternate method is to check the resistance of the field by connecting an ohmmeter to the two slip rings. If the resistance reading is below 2.4 to 2.8 ohms, the winding is shorted; if above this range, the winding has excessive resistance. The specified resistance value can be determined by dividing the voltage by 4.2 and 5.0 A.
4. Remember that the winding resistance and ammeter readings will vary slightly with winding temperature changes. If the rotor is not defective, but the alternator fails to supply rated output, the defect is in the diode trio, Fig. 10.30, rectifier bridge, stator, or regulator.

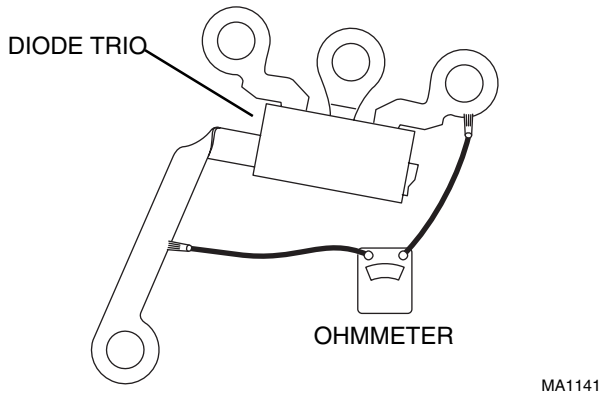


Fig. 10.31 Diode Trio Check

f. Diode Trio Check

1. The diode trio is identified in Fig. 10.31. To check the diode trio, remove it from the end frame assembly by detaching the three nuts, the attaching screw, and removing the stator assembly. Note that the insulating washer on the screw is assembled over the top of the diode trio connector.
2. Connect an ohmmeter having a 1-1/2-V cell, and using the lowest range scale, to the single connector and to one of the three connectors. Observe the reading. Then reverse the ohmmeter leads to the same two connectors. If both readings are the same, replace the diode trio. A good diode trio will give one high and one low reading.

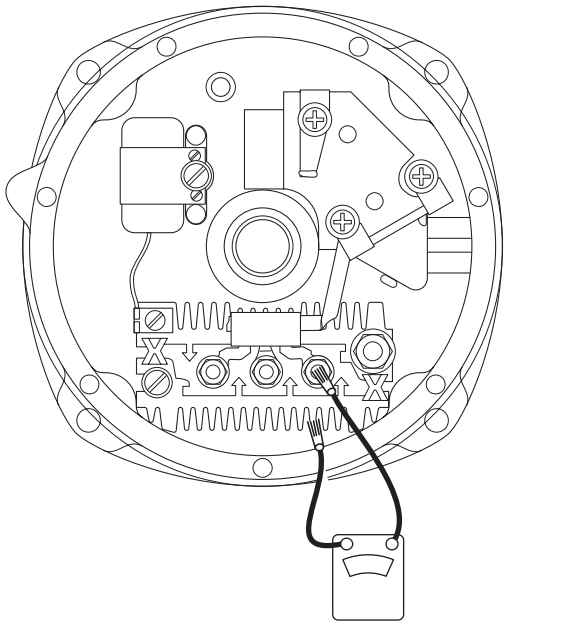


Fig. 10.32 Rectifier Bridge Check

3. Repeat the same test between the single connector and each of the other two connectors. Also, connect the ohmmeter to each pair of the three connectors (not illustrated). If any reading is zero on this test, replace the diode trio.

g. Rectifier Bridge Check

1. To check the rectifier bridge, connect the ohmmeter to the grounded heat sink and one of the three terminals as shown in Fig. 10.32. Then reverse the lead connections to the grounded heat sink and same terminal. If both readings are the same, replace the rectifier bridge. A good rectifier bridge will give one high and one low reading.
2. Repeat this test between the grounded heat sink and the other two terminals, and between the insulated heat sink and each of the three terminals. This makes a total of six checks, with two readings taken for each check.
3. To replace the rectifier bridge, remove the attaching screws, and disconnect the capacitor lead. Note the capacitor lead clip is attached with a screw or press fit.

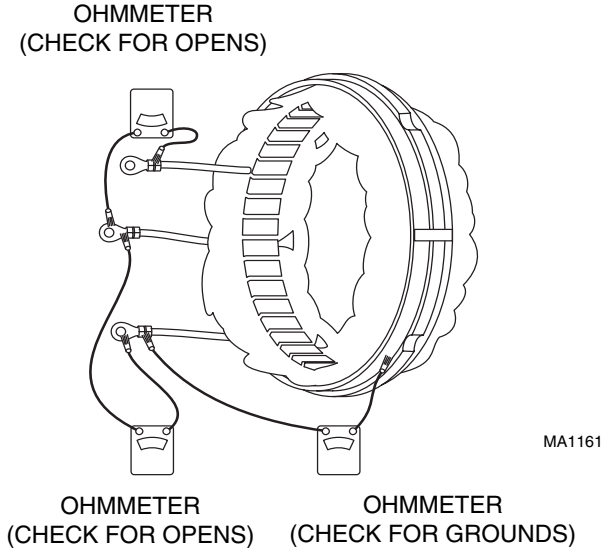


Fig. 10.33 Checking Stator Windings

h. Stator Checks

1. The stator windings may be checked with a 110 V test lamp or an ohmmeter, refer to Fig. 10.33. If the lamp lights, or if the meter reading is low when connected from any stator lead to the frame, the windings are grounded. If the lamp fails to light, or if the meter reading is high when successively connected between each pair of stator leads, the windings are open.

2. A short-circuit in the stator windings is difficult to locate without laboratory test equipment due to the low resistance of the windings. However, if all other electrical checks are normal and the alternator fails to supply rated output, shorted stator windings or an open delta winding are indicated. Also, a shorted stator can cause the indicator lamp to be on with the engine at low speed. Check the regulator in the next paragraph before replacing stator.

i. Brush Holder and Regulator Replacement

IMPORTANT: *To determine if the regulator is defective, use an approved regulator tester.*

After removing the three attaching nuts, and diode trio screw, Fig. 10.30, the brush holder and regulator may be replaced by removing the two remaining screws. Note the two insulators located over the top of the brush clips in Fig. 10.30 and that these two screws have special insulating sleeves over the screw body above the threads. The third mounting screw may or may not have an insulating sleeve. If not, this screw must not be interchanged with either one of the other two screws, as a ground may result, causing no output or uncontrolled alternator output.

j. Slip Ring Servicing

If the slip rings are dirty, they may be cleaned and finished with 400 grain or finer polishing cloth. Spin the rotor, and hold the polishing cloth against the slip rings until they are clean.

IMPORTANT: *The rotor must be rotated in order to clean the slip rings evenly. Cleaning the slip rings by hand without spinning the rotor may result in flat spots on the slip rings, causing brush noise.*

Slip rings which are rough or out of round should be trued in a lathe to 0.002" (0.05 mm) maximum indicator reading. Remove only enough material to make the rings smooth and round. Finish with 400 grain or finer polishing cloth and blow away all dust.

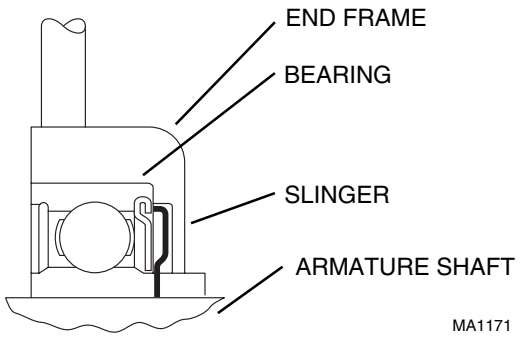


Fig. 10.34 Drive End Bearing Assembly
(Some Models Use a Flat Washer Instead of a Slinger)

k. Bearing Replacement and Lubrication

The bearing in the drive end frame can be removed by detaching the retainer plate screws, and then pressing the bearing from the end frame, refer to Fig. 10.34. If the bearing is in satisfactory condition, it may be reused, and it should be filled one-quarter full with Delco Remy Lubricant No. 1948791 before reassembly.

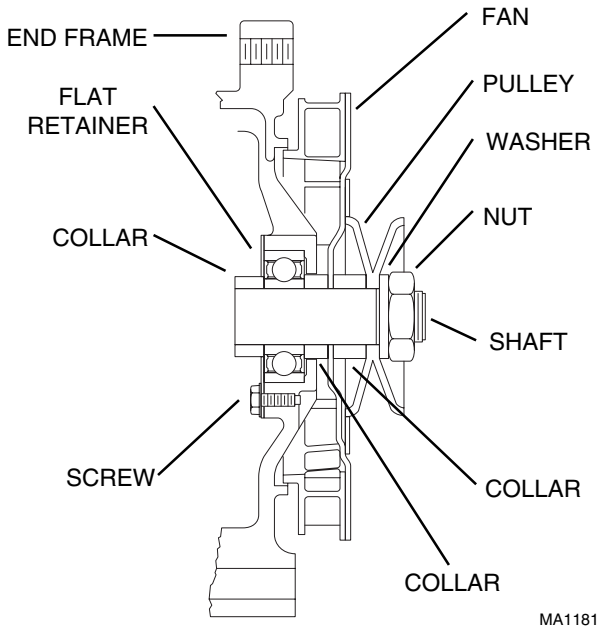


Fig. 10.35 Drive End Bearing Assembly, Late Production, All Series

IMPORTANT: *Do not overfill, as this may cause the bearing to overheat, and use only 1948791 Lubricant. The bearing in Fig. 10.35 is sealed on both sides; lubrication is not required.*

To install a new bearing, press in with a tube or collar that just fits over the outer race, with the bearing assembled into the end frame as shown in Fig. 10.34. Install a new retainer plate if the felt seal in the retainer plate is hardened or excessively worn. Fill the cavity between the retainer plate and bearing with 1948791 Lubricant. The bearing in Figure 10.34 is sealed on both sides; lubrication is not required.

Replace the bearing in the slip ring end frame if its grease supply is exhausted. No attempt should be made to lubricate or reuse the bearing. To remove the bearing from the slip ring end frame, press out with a tube or collar that just fits inside the end frame housing. Press from the outside of the housing towards the inside.

To install a new bearing, place a flat plate over the bearing and press in from the outside towards the inside of the frame until the bearing is flush with the outside of the end frame. Support the inside of the

frame with a hollow cylinder to prevent breakage of the end frame. Be extremely careful to avoid misalignment or otherwise placing undue stress on the bearing.

If the seal is separate from the bearing, it is recommended that a new seal be installed whenever the bearing is replaced. Press the seal in with the lip of the seal toward the rotor when assembled, that is, away from the bearing. Lightly coat the seal lip with oil to facilitate assembly of the shaft into the bearing.

l. Alternator Reassembly

Reassembly is the reverse of disassembly.

1. Place the rotor in a vise, position the drive end frame on the rotor, and install shaft nut (18, Fig. 10.28).
2. Remove protective tapes which were applied during alternator disassembly, refer to paragraph d. To install the slip ring end frame assembly to the rotor and drive end frame assembly, remove the tape over the bearing and shaft, and make sure the shaft is perfectly clean after removing the tape.
3. Insert a pin through the holes to hold up the brushes.
4. Carefully install the shaft into the slip ring end frame assembly to avoid damage to the seal.
5. Join the halves of the alternator by installing the four thru bolts and nuts.
6. After tightening the thru-bolts remove the brush retaining pin to allow the brushes to fall down onto the slip rings.
7. Remember when assembling the pulley to secure the rotor in a vise only tight enough to permit tightening the shaft nut to 40-60 lb- ft (54-81 N m). If excessive pressure is applied against the rotor, the assembly may become distorted.

m. Alternator Bench Check

To check the alternator in a test stand, proceed as follows:

1. Make connections as shown in Fig. 10.36, except leave the carbon pile battery tester disconnected.

IMPORTANT: *Ground polarity of battery and alternator must be the same. Use a fully charged battery, and a 10 ohm resistor rated at six watts or more between the alternator No. 1 terminal and the battery.*

2. Slowly increase the alternator speed and observe the voltage.
3. If voltage is uncontrolled with speed and increases above 15.5 volts on a 12-volt system, test regulator with an approved regulator tester, and check field winding.

NOTE: The battery must be fully charged when making this check.

4. If voltage is below 15.5 volts on a 12-volt system, connect the carbon pile as shown.
5. Operate the alternator at moderate speed as required and adjust the carbon pile as required to obtain maximum current output.
6. If output is within 10 amperes of rated output as stamped on the alternator frame, alternator is good.
7. If output is not within 10 amperes of rated output, keep battery loaded with carbon pile, and ground alternator field, Fig. 10.27.
8. Operate alternator at moderate speed and adjust carbon pile as required to obtain maximum output.
9. If output is within 10 amperes of rated output, test regulator with an approved regulator tester, and check field winding.
10. If output is not within 10 amperes of rated output, check the field winding, diode trio, rectifier bridge, and stator as previously covered.

n. Alternator Installation

1. If necessary, install pulley (21, Fig. 10.28), belt (20), washer (19), and hex nut (18).
2. If necessary, install stud (17), bracket (16), washers (15) and washers (14).
3. Position alternator (22) on the engine and install sleeve (12), sleeve (11), screw (10), washer (9), self-locking nut (8).
4. Install spacer (7), lever (6), lock washer (5), and screw (4).
5. Install washer (3), lock washer (2) and screw (1).
6. Connect negative (–) cable (2, Fig. 10.38) to batteries.

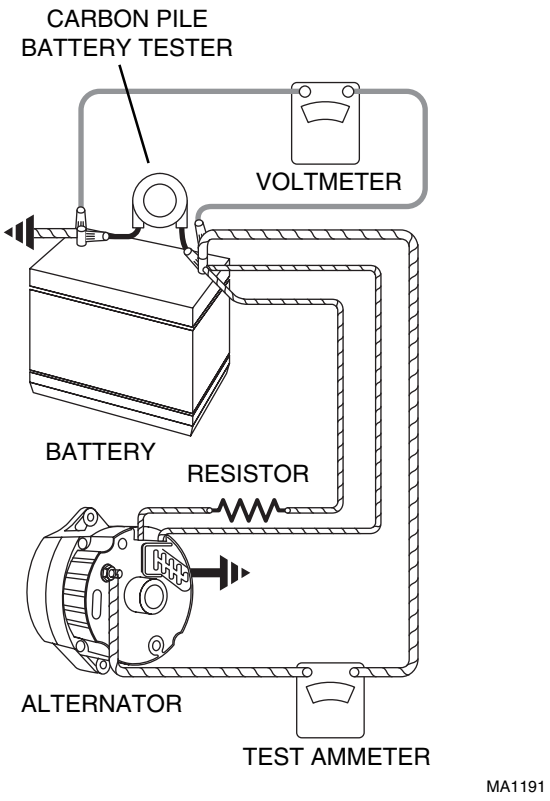


Fig. 10.36 Connections for Bench Check of Alternator

o. Service Test Specifications

The JLG Alternator, Part Nos. 8270217 and 8270219, are also identified by Delcotron Alternator Model 1101228, Series 12SI, Type 100, Specification No. 7236. It has the following service test specifications:

- Negative ground. When connected to a battery, the ground polarity of the alternator must be the same as the ground polarity of the battery.
- Clockwise rotation viewing from drive end.
- 2.4 to 2.8 field ohms at 80 °F (27 °C). A high ohmmeter reading indicates excessive resistance, and a low reading indicates shorted field windings, which can cause regulator failure.
- 4.2 to 5.0 A field current at 80 °F (27 °C) and 12 V. A low ammeter reading indicates excessive resistance, and a high reading indicates shorted field windings.
- Cold output of 23 A at approximately 1600 rpm, 66 A at 6500 rpm. These outputs are with the alternator at 80 °F (27 °C).

NOTE: A voltmeter is not needed for output check. Load battery with carbon pile battery tester to obtain maximum output. Refer to paragraphs b and n for test procedures.

10.6.2 Batteries

Warning !

All lead-acid batteries generate hydrogen gas which is highly flammable. If ignited by a spark or flame, the gas may explode violently, causing spraying of acid, fragmentation of the battery, and possible severe personal injuries. Wear safety glasses when working near batteries. In case of contact with acid, flush immediately with water.

a. Description

The batteries supply power to the starter and ignition systems to crank the engine. They supply the extra power required when the electrical load requirements of the forklift exceed the supply from the charging system in case of a alternator or charging failure, and acts as a voltage stabilizer in the electrical system, smoothing out or reducing temporarily high voltage.

With the correct cables properly attached, and with the batteries properly mounted, the batteries never need periodic maintenance.

When starting the forklift, crank for a maximum of 15 seconds, then rest for two minutes to avoid burning up the starter. Do not idle excessively.

Keep the batteries from freezing by maintaining a full charge. A completely discharged battery will freeze at 18 °F (8 °C).

When winterizing the forklift, test the start/charge system in accordance with the diagnostic procedures supplied with Generator Tester Model J-26290 (refer to paragraph 10.6.1.a). Required diagnostic equipment includes a variable carbon pile battery tester (500 A minimum with ammeter); a separate digital voltmeter that is calibrated frequently, and an inductive (clamp-on) ammeter. Test areas are: batteries, starter motor replacement test, starter circuitry and battery cable test, solenoid circuit test, magnetic switch control circuit test, alternator wiring test, and a alternator output test.

Water never has to be added to the batteries. There are no filler caps. Each battery is sealed, except for small vent holes in the cover. The vents allow what small amount of gasses that are produced in the battery to escape. The special chemical composition inside the battery reduces gassing to a very small amount at normal charging

voltages. Besides reducing gassing, the special chemistry greatly reduces the possibility of overcharge damage.

The vents require keeping the battery in an upright position to prevent electrolyte leakage. Tipping the battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out the vent hole.

DO NOT exceed this 45° angle when carrying or installing a battery.

Evidence of electrolyte leakage does not necessarily mean a battery is defective.

The battery has top post terminals. Securely tighten clean cable clamps to the posts. Grease or special spray sealers may be applied over the connections.

b. Visual Inspection of a Battery

Inspect for damage such as a cracked or broken case or cover that could permit loss of electrolyte. If obvious physical damage is noted, replace battery. Handle the battery with care. Determine cause of damage and correct as needed.

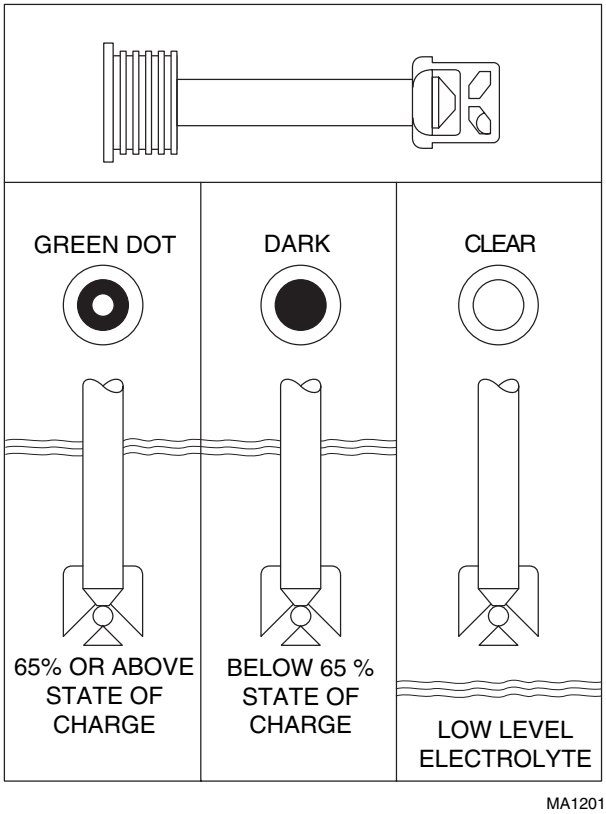


Fig. 10.37 Typical Hydrometer Operation

c. Built-In Hydrometer

A special temperature-compensated hydrometer is built into the cover of each battery to show at a glance the battery's state-of-charge. The hydrometer has a green ball within a cage which is attached to a clear plastic rod; refer to Fig. 10.37.

It is important when observing the hydrometer that the battery have a clean top to see the correct indication. A flashlight may be required in some poorly lit areas.

IMPORTANT: *Always look straight down when viewing the hydrometer.*

The green ball will float at a predetermined specific gravity of the electrolyte that represents about a 65 percent state-of-charge. When the green ball floats, it rises within the cage and positions itself under the rod. Visually a green dot then shows in the center of the hydrometer; refer to Fig. 10.37. The built-in hydrometer provides a guide for battery testing and charging.

In testing, the GREEN DOT means the battery is charged enough for testing. If the green dot is not visible and the center of the hydrometer has a DARK appearance, it means the battery must be charged before the test procedure is performed.

In charging, the appearance of the green dot means that the battery is sufficiently charged. Charging can be stopped to prevent overcharging.

The hydrometer on some batteries may be CLEAR or light yellow; refer to Fig. 10.37. This means the fluid level may be below the bottom of the rod and attached cage. This may have been caused by excessive or prolonged charging, a broken case, excessive tipping, or normal battery wear out.

IMPORTANT: *Whenever this clear or light yellow appearance is present when looking straight down on the hydrometer, always tap the hydrometer lightly with a small screwdriver to dislodge any gas bubbles that may be giving a false indication of low electrolyte level. If the clear or light yellow appearance remains, and if a cranking complaint exists that is caused by the battery, replace the battery.*

Complete hydrometer information is printed on a label on top of the battery. Refer to this label to accurately interpret hydrometer appearance.

d. Battery Load Test

1. Remove cable clamps and be sure parts are clean for a good connection.

Relation of Battery Temperature to Minimum Voltage

Temperature	(21 °C) 70 °F & Above	(10 °C) 50 °F	(–1 °C) 30 °F	(–10 °C) 15 °F	(–18 °C) Below 0 °F	0 °F
Minimum Voltage	9.6	9.4	9.1	8.8	8.5	8.0

2. Attach voltmeter and battery load tester clamps to posts.
3. Remove surface charge from any battery that has just been on charge IF THE GREEN DOT IS VISIBLE. This includes batteries in the vehicle having been charged by the vehicle alternator. *Do not remove surface charge from batteries that have been in storage.* To remove surface charge, apply a 300-ampere load across the terminals for 15 seconds. Then turn off load and wait for 15 seconds to allow the battery to recover.
4. Battery temperature should be estimated by touch and also by the surrounding temperature it was exposed to during the preceding few hours before testing. Select the nearest estimated temperature in the table below and determine the minimum voltage which must be maintained while the battery supplies a specified electrical load
5. Apply a 260 A load test. Observe voltage after 15 seconds with load connected; then turn off load.
6. If voltage is below value determined in step 4, replace battery.
7. If voltage is at or above value determined in step 4, battery is good and may be returned to service.
8. Check the charge acceptance of the battery one more time before discarding it.

e. Battery Charging

1. Do not charge battery if hydrometer is clear or light yellow; replace battery.
2. Charge rates between 3 and 50 amperes are generally satisfactory as long as spewing of electrolyte does not occur or the battery does not feel excessively hot [over 125 °F (52 °C)]. Battery temperature can be estimated by touching or feeling the battery case. If spewing occurs or temperature exceeds 125 °F (52 °C), the charging rate must be reduced or temporarily halted to permit cooling.
   - The battery is sufficiently charged when the green dot in the built-in hydrometer is visible. No further charging is required. Shake or tilt the battery at hourly intervals during the charging to mix the electrolyte and see if the green dot appears.
   - Battery charging consists of a charge current in amperes for a period of time in hours. Thus, a 25-ampere charging rate for 2 hours would be 50 ampere-hour charge to the battery. In most cases, batteries whose load test values are less than 200 amperes (see Battery Testing Procedure) will have the green dot visible after at least a 50 ampere-hour charge. Most batteries whose load test values are greater than 200 amperes will have the green dot visible after at least a 75 ampere-hour charge. In the event that the green dot does not appear after this amount of charging, continue charging for another 50 or 75 ampere-hours. If the green dot still does not appear, replace the battery.

The time required for a charge will vary due to the following conditions:

- *Size of Battery.* For example, a completely discharged large heavy-duty battery requires more than twice the recharging as a completely discharged small passenger car battery.
- *Temperature.* For example, a longer time will be needed to charge any battery at 0 °F than at 80 °F. When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first, then in time the battery will accept a higher rate as the battery warms.
- *State-of-Charge.* A completely discharged battery requires more than twice as much charge as a one-half-charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will

likewise increase.

- *Charger Capacity.* A charger which can supply only 5 amperes will require a much longer period of charging than a charger that can supply 30 amperes or more.

f. Troubleshooting

If a battery has tested good and then has not performed satisfactorily in service for no apparent reason, the following are some of the more important factors that may point to the cause of trouble:

1. Vehicle accessories inadvertently left on overnight.
2. Defects in the charging system, such as slipping fan belt, high wiring resistance, or faulty alternator.
3. A vehicle electrical load exceeding the alternator capacity, with the addition of electrical devices, such as radio equipment, air conditioner, window defoggers or light systems.
4. Defects in the electrical system, such as shorted wires.
5. Extended slow speed driving with many accessories turned on.
6. Loose or poor battery cable-to-post connections, previous improper charging of a rundown battery, or loose hold-downs.
7. High-resistance connections or defects in the starting system.
8. Long periods of vehicle storage without disconnecting the batteries. Small current drains of vehicle accessories which are connected all the time can discharge the batteries in a six- to eight-week period. Batteries left in a discharged condition for a prolonged period of time are subject to freezing and can become difficult to recharge.

g. Jump Starting with Auxiliary (Booster) Battery

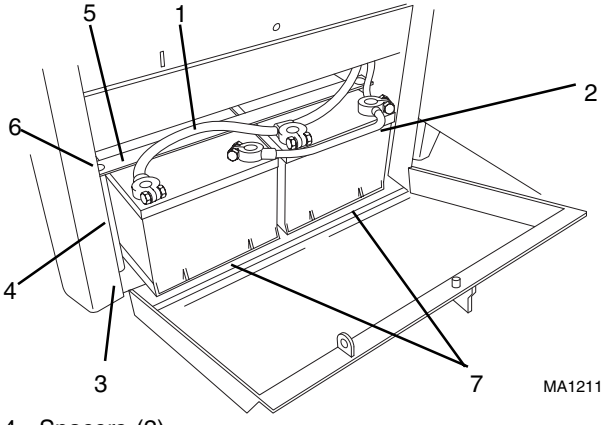
Both booster and discharged battery should be treated carefully when using jumper cables. Follow exactly the following procedure for this negative ground system, being careful not to cause sparks:

1. Engage park lock and place transmission in neutral. Turn off lights, optional heater and other electrical loads.
2. Observe charge indicator. If indicator is light, replace battery. If charge indicator is dark and has a green dot in the center, failure to start is not due to a discharged battery and the cranking system should be checked. If charge indicator is dark but the green dot does not appear in the center, proceed as follows:
3. Attach one end of one jumper cable to the positive terminal of the **booster battery** and the other end of the same cable to positive terminal of **discharged battery.** DO NOT PERMIT vehicles to touch each other as this could establish a ground connection and counteract the benefits of this procedure.
4. Attach one end of the remaining negative cable to the negative terminal of the **booster battery** and the other end to a ground at least 12 inches from the battery of the vehicle being started. (DO NOT CONNECT DIRECTLY TO THE NEGATIVE POST OF THE DEAD BATTERY).

Warning !

- Personal injury caused by electrolyte squirting out the battery vent;
- Personal injury or property damage due to battery explosion.
- Damage to the charging system of the booster vehicle or of the immobilized vehicle.

1. Positive (+) cable
2. Negative (–) cable
3. Two self-locking nuts (2)



4. Spacers (2)
5. Hold Down Strap
6. Bolts (2)
7. Batteries

Fig. 10.38 Battery Removal

h. Battery Removal

1. Prepare to remove the battery(s) by unlocking and opening door to battery compartment.
2. Disconnect the negative cable (2, 10.38) from the batteries.
3. Disconnect positive cable (1) from batteries.
4. Remove the two self-locking nuts (3) from below the cab floor and lift the spacers (4), hold down strap (5) and bolts (6) from the battery compartment.
5. Carefully lift the battery(s) from the battery compartment.

i. Battery Inspection, Cleaning and Drying

1. Periodically look for any accumulation of dirt or corrosion on top of the battery, corroded terminals and cables, broken or loose terminal posts, and container or cover that is broken or cracked.
2. Scrub the exterior of the battery and cable terminals by using a nonmetallic brush which has been dipped in a mixture of baking soda and water.
3. Dry the battery with a clean cloth.
4. Check the voltage regulator setting at every periodic maintenance inspection. Overcharging is a common cause of battery failure. The voltage setting should be 13.6 to 13.8, and never more than 14.0 V.

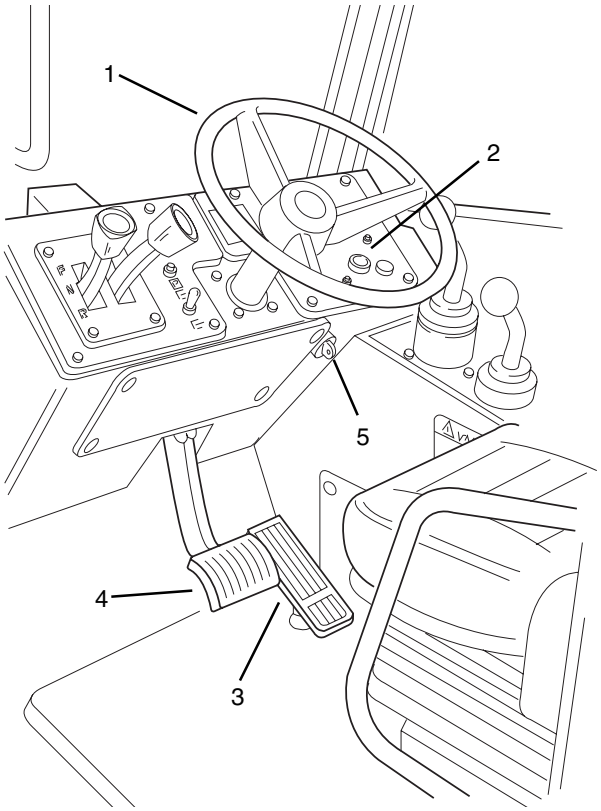
j. Battery Installation

1. Place batteries in battery compartment.
2. Install bolts (6, Fig. 10.38), spacers (4), hold down strap (5), and two self-locking nuts (3). DO NOT OVERTIGHTEN. Be sure hold-down strap is properly attached to keep batteries from bouncing. Vibration is very harmful to a battery.
3. Connect positive (+) cable (1) to the batteries.
4. Connect negative (–) cable (2) to batteries.
5. Close and lock door to battery compartment.

k. Battery Identification and Service Test Specifications

The JLG 12 V Battery, Part No. 8270014, is also identified by Delco Freedom Battery Cat. No. 24-60. BCI Group Size is 24 A.

- Load Test Amperage is 260.
- SAE/BCI reserve capacity in minutes is 95 minutes.
- Cold cranking current (SAE SPEC J537h) is 525 A at 0 °F (–18 °C)
- For battery warranty contact your local Delco distributor.



1. Steering Wheel
2. Horn
3. Accelerator Pedal
4. Service Brake Pedal
5. Ignition (Key) Switch

Fig. 10.39 Forklift Operating Components

10.7 SWITCHES AND SOLENOIDS

10.7.1 Ignition (Key) Switch

By using the key, the ignition switch (5, Fig. 10.39) may be turned clockwise from the OFF position to the RUN, THERMO START AND START positions. The THERMO START AND START positions are spring-loaded to return to the RUN position and must be manually held in place for cold starting or normal starting. When starting in cold weather, momentarily hold the key in the THERMO START position before turning it fully to the START position.

- In the OFF position, the entire electrical system is shut down (there is power to ignition switch and to starter solenoid only).
- In the RUN position, all controls and indicators are operable.

- In the RUN position with the Park Lock engaged, park lock warning, oil pressure and alternator lights must be ON. Press Bulb Check switch; remaining warning lights must turn ON.
- In the THERMO START position, the ignition switch energizes the Thermo Start plug (Fig. 10.24) which ignites a fuel/air mixture in the intake manifold to facilitate cold weather starting. Refer to paragraph 10.5.5 for Thermo Start plug removal and installation instructions.
- In the START position (with the parking lock engaged and the travel select lever in neutral) the starter pinion engages the flywheel to start the engine.

If the key binds in the lock, check for a sticky, painted or bent key. If key is sticky, clean key. If key is painted, remove paint. If key is bent, straighten key. If the key is straight and usable, sprinkle some powdered graphite on the sides of the key and insert key in lock several times to distribute the graphite. If the lock should fail to accept key or fail to turn due to freezing temperatures, warm the key switch using a hair dryer or use a liquid lock deicer to lower the freezing point and evaporate the moisture within the lock.

IMPORTANT: *Use only graphite or a liquid lock deicer within the lock. Severe lock malfunctions may require the services of a locksmith.*

a. Removal

1. Prepare to remove ignition switch by removing lower panel (7, Fig. 10.40) next to the switch.
2. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
3. Remove the hex nut which secures the switch to the console.
4. Carefully tilt the switch as required to reposition switch in lower panel opening.
5. Tag and disconnect the wires from the switch.

b. Disassembly

Do not disassemble the ignition switch.

c. Cleaning and Drying

Without submerging the switch, clean the exterior of the switch with an approved solvent and dry with a clean lint-free cloth.

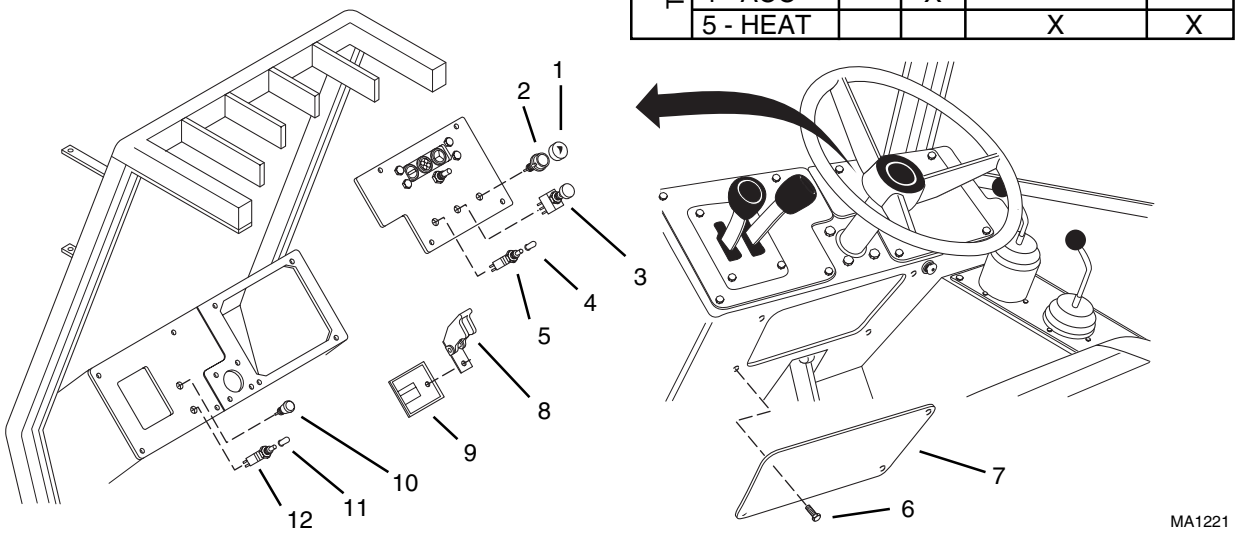
d. Inspection and Replacement

1. Key should insert and turn freely in switch. If the key binds in the lock, check for a bent key. If the key is straight, sprinkle some powdered graphite on the sides of the key and insert key in lock several times to distribute the graphite.

IMPORTANT: *Use only graphite or a liquid lock deicer within the lock. Severe lock malfunctions may require the services of a locksmith.*

2. Refer to the table below. Using an ohmmeter or continuity tester, check for continuity as follows:

		SWITCH POSITION			
		OFF	RUN	THERMO START	START
Switch Terminals	1 - BAT		X	X	X
	2 - IGN		X	X	X
	3 - START				X
	4 - ACC		X		
	5 - HEAT			X	X



1. Seal Cap
2. Horn Button
3. Washer/Wiper Switch
4. Seal Cap
5. Steering Select Switch
6. Capscrew, hex hd
7. Lower Panel
8. Switch Guard
9. Decal
10. Park Lock Warning Light
11. Seal Cap
12. Park Lock Switch

Fig. 10.40 Removal of Switches and Indicators

3. Replace the switch if it fails the tests in step 2.

e. Installation

1. Connect the wires as they were tagged during switch removal.
2. Position the switch from under the panel.
3. Install hex nut.
4. Connect negative (–) cable (2, Fig. 10.38) to the batteries.
5. Install lower panel (7, Fig. 10.40).

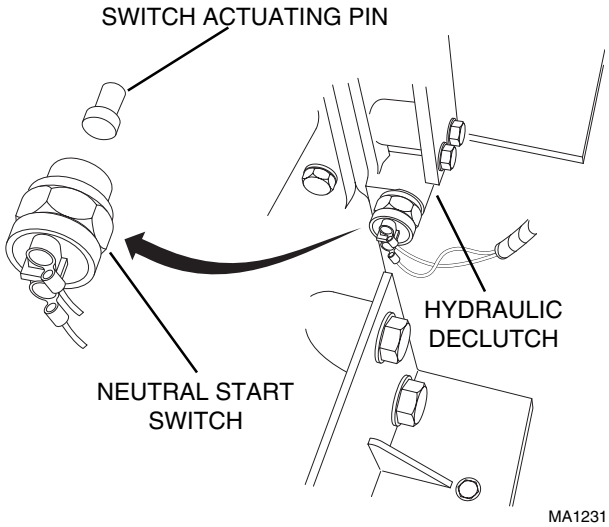
10.7.2 Neutral Start Switch

The neutral start switch, Fig. 10.41, prevents the engine from being started with the transmission in forward or reverse.

The switch is located on the transmission control valve assembly. The switch is normally open and is closed when a switch actuating pin presses a spring-loaded ball in the neutral start switch.

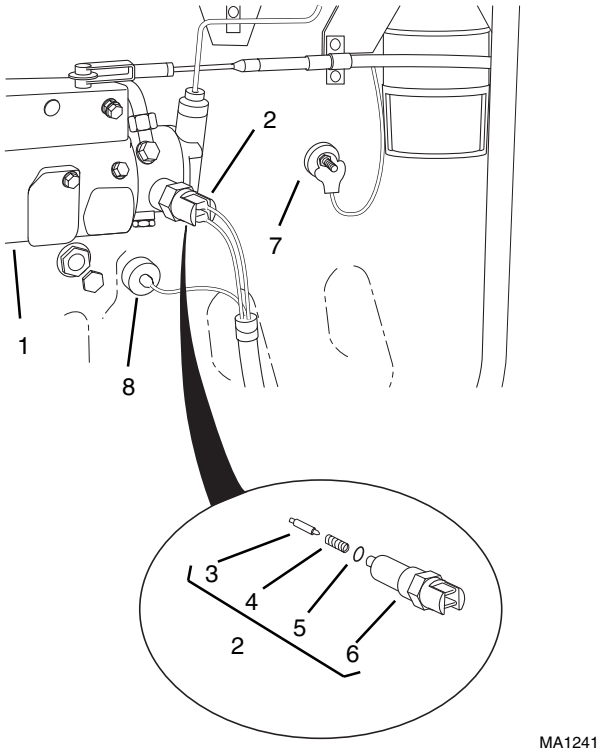
Test the neutral start circuit as follows:

- Starter MUST NOT operate with travel select lever in FORWARD or REVERSE positions.
- Starter MUST NOT operate when park lock is DISENGAGED.
- Starter MUST operate with travel select lever in NEUTRAL position.



1. Neutral Start Switch
2. Switch Actuating Pin
3. Control Valve Housing Assembly
4. Forward, Neutral and Reverse Valve Spool
5. Oil Seal
6. Valve Spool Stop

Fig. 10.41 Neutral Start Switch



1. Fuel Injection Pump
2. Fuel Run Solenoid
3. Plunger
4. Spring
5. O-ring
6. Solenoid
7. Engine Coolant Heater
8. Low Oil Pressure Sender

Fig. 10.42 Fuel Run Solenoid, Coolant Heater and Low Oil Pressure Sender

If the starter fails to rotate the engine with the travel select lever in NEUTRAL and the ignition key in the START:

1. Check for problems in the shift lever linkage.
2. Check the neutral start switch, it may not be closing.
3. Remove the switch from the control valve assembly and check the actuator pin in the control valve assembly for free movement.
4. Make a continuity check across the terminals of the switch with the actuator ball manually depressed. If circuit is open replace the neutral start switch.

10.7.3 Fuel Run Solenoid

The fuel run solenoid valve (2, Fig. 10.42) lets fuel enter the injection pump when the ignition key is turned to START or RUN.

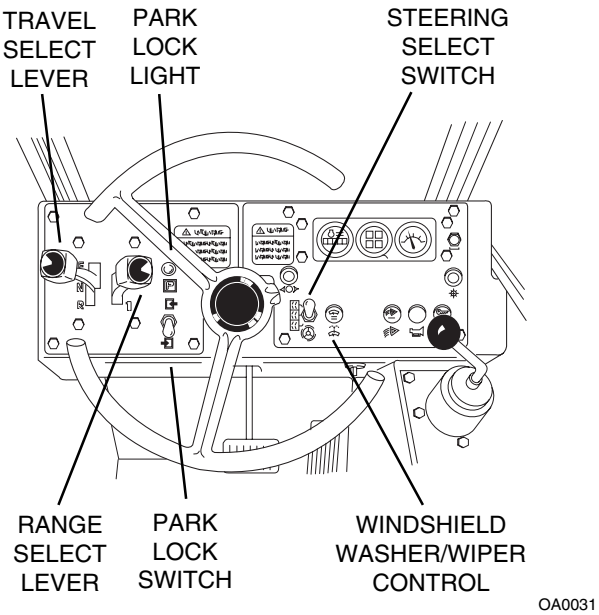


Fig. 10.43 Control Panel

a. Removal

1. Engage the park lock, place the travel select lever in neutral, and turn the ignition switch to OFF.
2. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
3. Unlock and open the right engine access door to gain access to the fuel injection pump.
4. Tag and remove electric wires.
5. A plunger and spring may fall from the solenoid when it is removed from the fuel injection pump. Be prepared to catch these parts when you remove the solenoid. Use an appropriate wrench to turn the solenoid counterclockwise.
6. Discard the O-ring.

b. Disassembly

Do not disassemble the fuel run solenoid.

c. Cleaning and Drying

Without submerging the electrical components, clean the fuel run solenoid using a approved solvent and dry using a clean lint-free cloth.

d. Inspection and Replacement

1. Prepare to test the fuel run solenoid by assembling the valve at a bench.
2. Inspect the rubber tip on the plunger and replace plunger if tip is worn.
3. Lubricate valve core and plunger using clean fuel oil.
4. Place the spring and plunger in the solenoid.
5. Energize the solenoid using 12 Vdc to see if the plunger retracts. Replace fuel run solenoid if it doesn't retract.

e. Installation

1. Clean exterior of fuel injection pump.
2. Install a new O-ring on the fuel run solenoid.
3. Remove protective plug from fuel injection pump.
4. With spring and plunger in solenoid, turn fuel run solenoid into fuel injection pump, being careful to avoid cross threading. Tighten until snug.
5. Connect electric wires and connect negative cable to batteries.
6. Close and lock the engine access door.
7. Prepare to test fuel run solenoid by clearing personnel and any obstructions from the area around the forklift.
8. Start the engine.
   - If engine starts the solenoid is functioning.
   - If engine fails to start, solenoid may have a poor ground connection. Check voltage at solenoid.
9. Check for fuel oil leakage around solenoid.

10.7.4 Park Lock Switch

The park lock switch, Fig. 10.43, has two positions, engaged and disengaged. To engage, lift cover and flip lever up. To disengage, lower switch cover.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from batteries.
2. Prepare to remove park lock switch, Fig. 10.43, by removing the lower panel which is located below the switch.
3. Tag and disconnect electric wires from the switch.
4. Remove hex nut cap seal and the hex nut which secures switch to left front console panel.
5. Remove switch guard and decal.

b. Disassembly

Do not disassemble the park lock switch.

c. Cleaning and Drying

1. Clean and condition the hex nut cap seal using an appropriate vinyl cleaner.
2. Without submerging the switch, clean the switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity and shorting in the ENGAGED and DISENGAGED positions.
2. Replace switch if it fails the tests in step 1.

e. Installation

1. Connect electric wires as tagged during switch removal.
2. Position park lock switch, Fig. 10.43, under panel.
3. Position switch guard over switch stem.
4. Install hex nut and hex nut cap seal.
5. Connect negative (–) cable (2, Fig 10.38) to batteries.
6. Prepare to test park lock engagement and disengagement by clearing the area around the forklift of persons and any obstructions to forklift travel.
   - To test for engagement, engage the park lock switch, place the drive in forward or reverse and second or medium gear and apply full throttle. The forklift should remain motionless in both forward and reverse positions.
   - To test for disengagement, firmly depress service brake pedal, disengage park lock switch, place drive in forward or reverse and first or low gear, and slowly press the throttle pedal while releasing the brake pedal. The park lock should release and the forklift should be free to travel.

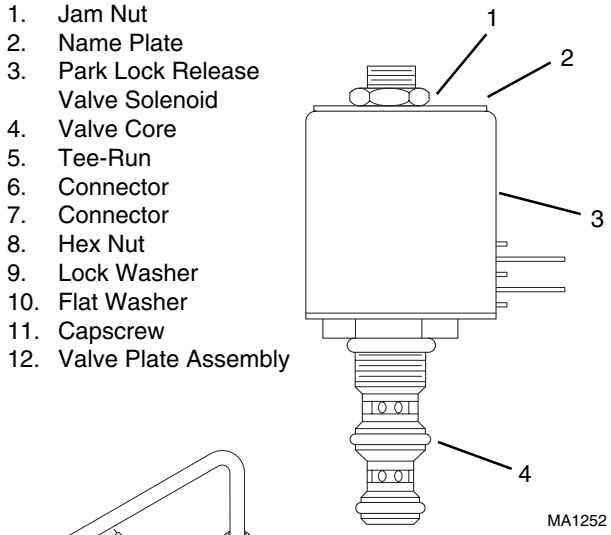
10.7.5 Park Lock Release Valve Solenoid

The 3-way, 2-position, park lock release valve solenoid is threaded into the park lock release valve. The valve is located under the cab on the valve plate assembly.

a. Removal

1. Engage the PARK LOCK, place the travel select lever in NEUTRAL, and turn ignition switch to OFF.

1. Jam Nut
2. Name Plate
3. Park Lock Release Valve Solenoid
4. Valve Core
5. Tee-Run
6. Connector
7. Connector
8. Hex Nut
9. Lock Washer
10. Flat Washer
11. Capscrew
12. Valve Plate Assembly



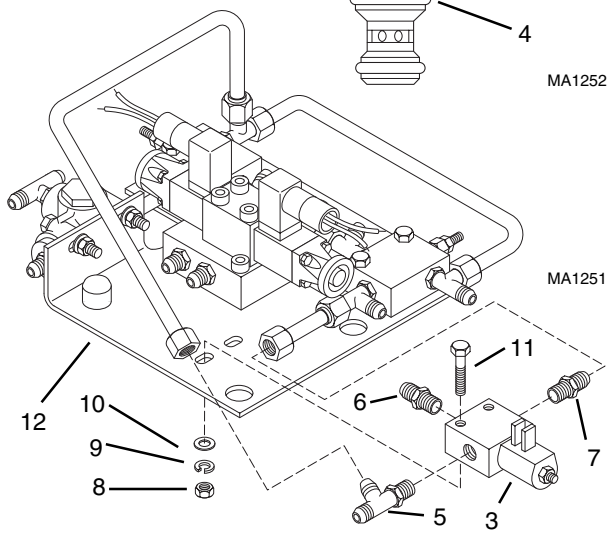


Fig. 10.44 Park Lock Release Valve Solenoid

2. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.

Warning !

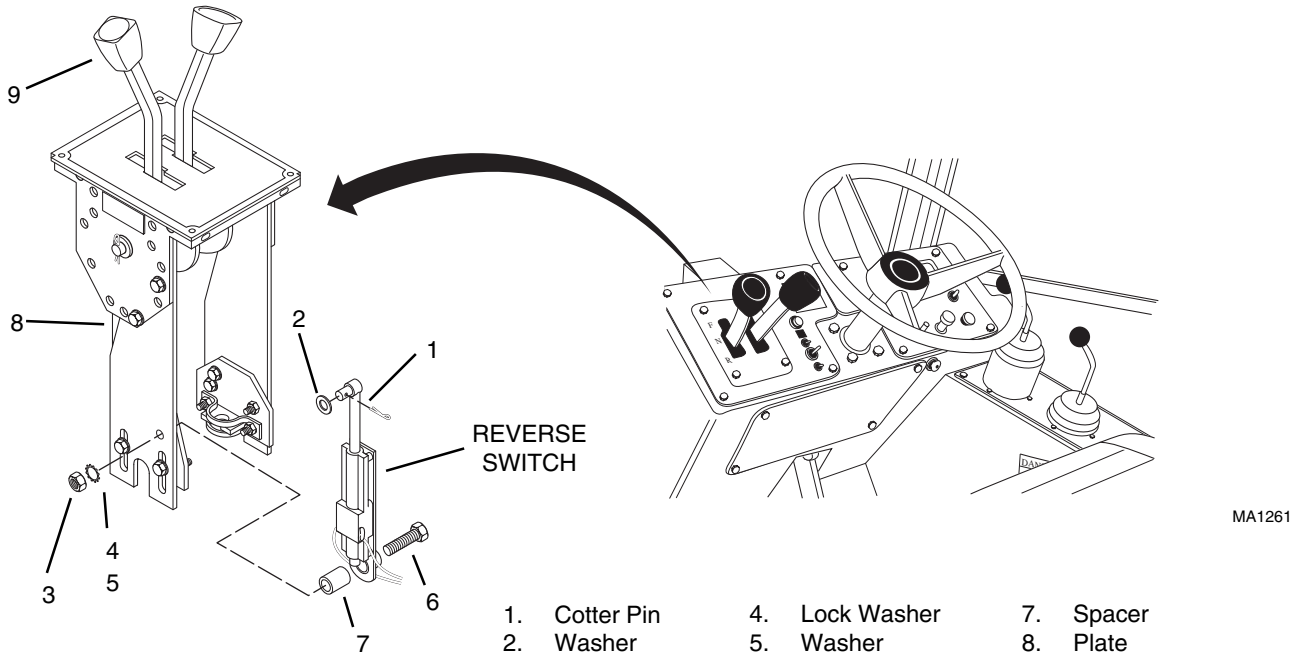
Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

3. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning !

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

4. Disconnect and tag the two wires attached to the solenoid valve.
5. Remove the jam nut (1, Fig. 10.44) and name plate (2) from the end of the solenoid valve.



1. Cotter Pin
2. Washer
3. Hex Nut
4. Lock Washer
5. Washer
6. Capscrew
7. Spacer
8. Plate
9. Transmission Shifter

Fig. 10.45 Reverse Switch

6. Slide the solenoid from valve cartridge stem.
7. If the valve cartridge (4) is leaking or malfunctioning, remove the cartridge from the park lock release valve by turning the cartridge counterclockwise; then plug the opening in the park lock release valve.
8. Remove the three O-ring seals from the valve cartridge and discard the seals.

b. Disassembly

Do not disassemble the park lock release valve solenoid.

c. Cleaning and Drying

1. Carry the park lock release valve solenoid to a clean working area.
2. Without submerging the solenoid, clean the solenoid in an approved solvent and dry using a lint-free cloth.

d. Inspection and Replacement

1. Prepare to test the park lock release valve solenoid cartridge by assembling the solenoid onto the cartridge stem at the bench.
2. Lubricate the internal valve piston using clean filtered hydraulic fluid.
3. Energize the solenoid using 12 Vdc to see if the internal cartridge piston retracts into the stem. Discard the park lock release valve solenoid cartridge if it doesn't shift.

e. Installation

1. Clean the exterior of the park lock release valve on the valve plate, Fig. 10.44, to prepare it for installation of the park lock release valve solenoid cartridge.
2. Install three new O-ring seals on the valve cartridge.
3. Thread the park lock release valve solenoid cartridge into the park lock release valve on the valve plate by turning the cartridge clockwise until it firmly seats against the valve.
4. Slide the solenoid (3) and nameplate (2) over the cartridge (4) stem and secure these components with the jam nut (1).
5. Refer to the tags attached during removal and connect the wires to the solenoid.
6. Connect negative (–) cable (2, Fig 10.38) to the batteries.

Warning !

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

7. Prepare to test park lock engagement and disengagement by clearing the area around the forklift of persons and any obstructions to forklift travel.

- To test for engagement, engage the park lock switch, place the drive in forward or reverse and second or medium gear and apply full throttle. The forklift should remain motionless in both forward and reverse positions.
- To test for disengagement, firmly depress service brake pedal, disengage park lock switch, place drive in forward or reverse and first or low gear, and slowly press the throttle pedal while releasing the brake pedal. The park lock should release and the forklift should be free to travel.

10.7.6 Reverse Switch

The reverse switch, Fig. 10.45, causes a backup alarm to sound at the rear of the forklift when the travel select lever is shifted into REVERSE. The reverse switch has two positions, reverse and neutral. Place travel select lever in REVERSE to test alarm. Reverse alarm must NOT sound in FORWARD or NEUTRAL.

a. Removal

1. Prepare to remove reverse switch by removing lower panel (7, Fig. 10.40) located below switch.
2. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
3. Tag and disconnect the wires from the switch.
4. Observe and mark hole location at top of switch and remove cotter pin (1, Fig. 10.45).
5. Disengage switch arm and remove washer (2) at pivot.
6. Remove hex nut (3), lock washer (4) and washer (5) at bottom of switch.
7. Remove capscrew (6), spacer (7) and switch from transmission shifter (9).

b. Disassembly

Do not disassemble the switch.

c. Cleaning and Drying

Without submerging the switch, clean the switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity in the reverse position and shorting in the neutral position.
2. Replace the switch if it fails the tests in step 1.

e. Installation

1. Connect electric wires as tagged during switch removal.
2. Install capscrew (6, Fig. 10.45) through lower mounting hole in switch.
3. Install spacer (7) on screw and place screw in mounting hole in transmission shifter.
4. Install washer (5), lock washer (4) and hex nut (3). Torque nut to 80 to 85 lb-in. (9 to 9.6 N m).
5. Install washer (2) on pivot at top of switch arm and place pivot in hole marked during removal.
6. Install cotter pin (1) in pivot.
7. Check for smooth operation of travel select lever.
8. Connect negative (–) cable (2, Fig 10.38) to batteries.
9. Place travel select lever in REVERSE and turn ignition switch to ON; the backup alarm should sound.
10. Install lower panel (7, Fig. 10.40).

10.7.7 Steering Select Switch

The steering select switch, Fig. 10.43, has three positions, up for 4 wheel steer, center for 2 wheel steer, and down for crab steer. The switch is a single pole, double throw, toggle switch with three screw terminals.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from batteries.
2. Prepare to remove steer select switch, Fig. 10.43, by removing lower panel (7, Fig. 10.40).
3. Tag and disconnect the wires from the switch.
4. Remove hex nut which secures switch to right front console panel.

b. Disassembly

Do not disassemble the switch.

c. Cleaning and Drying

Without submerging the switch, clean switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

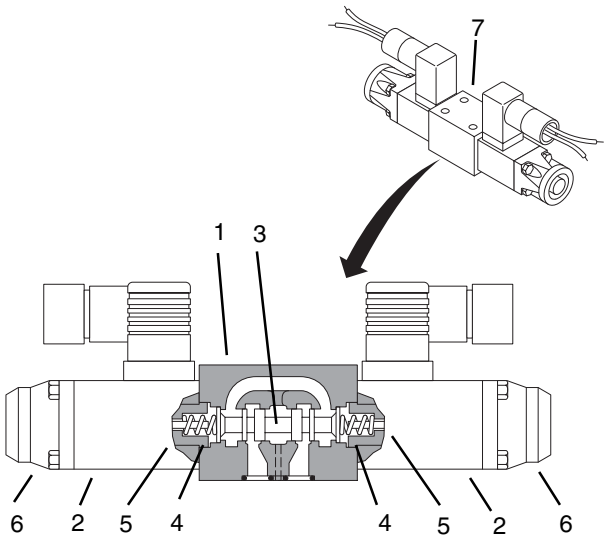
1. Inspect switch terminals for continuity in the up and down positions and shorting in the middle position.

2. Replace switch if it fails tests in step 1.

e. Installation

1. Connect the wires as they were tagged during switch removal.
2. Position the switch from under the right front console panel.
3. Install the switch and carefully tighten the hex nut.
4. Connect negative (–) cable (2, Fig. 10.38) to the batteries.
5. Test switch for proper operation:
   - UP for 4 wheel steer
   - CENTER for 2 wheel steer
   - DOWN for crab steer

   If operation is not correct rotate switch or reconnect wires.



1. Housing
2. Solenoids (2)
3. Control spool
4. Return springs
5. Push pin
6. Manual override
7. Steer-Select Solenoid-Operated Valve

Fig. 10.46 Typical Steer-Select Solenoid-Operated Valve

10.7.8 Steer Select Solenoid

The steer select valve is a direct solenoid-operated spool-type directional control valve. It controls the start, stop and direction of fluid flow to the steering cylinders. It is located on the valve plate assembly which is mounted under the operator's cab.

The valve consists of a housing (1, Fig. 10.46), two solenoids (2), a control spool (3) and two return springs (4).

In the de-energized condition, the spool (3) is held by the return springs (4) in the center position. The spool is shifted by energizing wet pin solenoids (2).

The force of the solenoid (2) pushes against push pin (5) on the end of spool (3). The spool is shifted from its normal position to the desired end position. This selects the desired flow pattern of P to A and B to T, or P to B and A to T. When the solenoid (2) is de-energized, the control spool (3) is returned to its normal condition by the centering springs (4).

A manual override (6) is provided for emergency operation of the valve (without electrical power). The valve is supplied with a rubber boot covered thumb button type manual override.

10.8 GAUGES AND INDICATOR LIGHTS

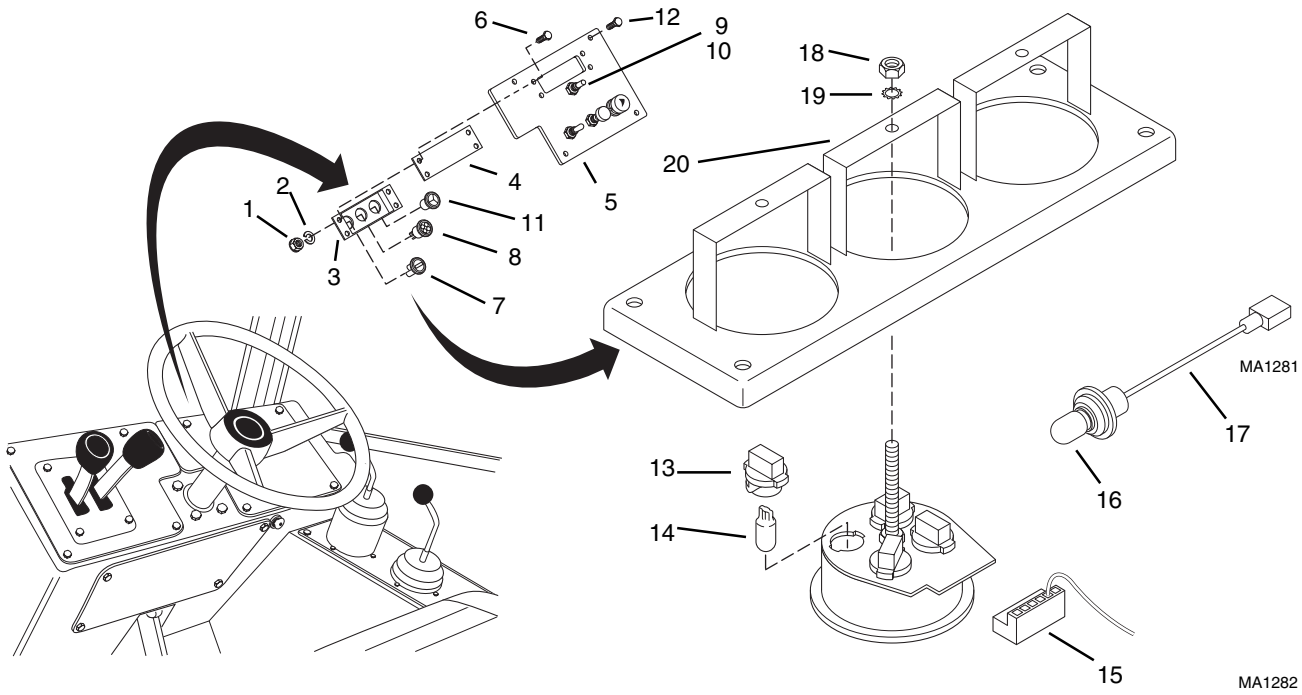
The gauge cluster contains an hourmeter, warning lights and a fuel level gauge. Removal and installation instructions for the gauge cluster are provided in paragraphs 10.47 and 10.48.

10.8.1 Removal of the Gauge Cluster

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Remove four hex nuts (1, Fig. 10.47) and lock washers (2) which secure gauge mounting plate (3) and gauge cover (4) to right console panel (5) and remove the four hex head screws (6) from the panel. Carefully break the rubber seal around the gauge mounting plate and cover and separate the plate and cover.
3. Service the gauge cluster as described in the following procedures for servicing of a specific component in the gauge cluster (refer to paragraphs 10.8.3, 10.8.4, 10.8.7 and 10.8.8.
4. Temporarily insulate all exposed wiring if it becomes necessary for you to connect the battery ground cable before you complete the removal and installation procedures.

10.8.2 Installation of Gauge Cluster

1. Clean gauge cover (4, Fig. 10.47).
2. Remove all old rubber sealant from gauge mounting plate (3) and gauge cover (4).
3. Position cover over gauge mounting plate. Examine the assembly for alignment and the cover for cleanliness. Apply a bead of silicon rubber sealing compound along the top and bottom surface of the gauge mounting plate



1. Nut, hex, 1/4"
2. Lock Washer, 1/4"
3. Gauge Mounting Plate
4. Gauge Cover
5. Right Console Panel
6. Screw, hex hd 1/4 by 3/4"
7. Hourmeter
8. Warning Lights Gauge
9. Seal Cap
10. Bulb Test Switch
11. Fuel Gauge
12. Flange Head Bolt
13. Bulb socket
14. Bulb
15. Connector
16. Bulb
17. Fuel gauge light assembly
18. Hex nut
19. Tooth type lock washer
20. Clip

Fig. 10.47 Gauges and Indicator Lights

(3) to minimize the entry of dust between the plate and the gauge cover (4). Leave the ends open to provide some ventilation.

4. Position the plate and cover under the right console panel (5) and secure with four hex head screws (6), lock washers (2) and hex nuts (1).
5. Connect any wiring removed in previous steps.
6. Position right console panel (5) and overlay on control console and secure with four screws (12).

10.8.3 Hourmeter

The hourmeter (7, Fig. 10.47) indicates the total elapsed hours of forklift operation. It is a solid state electronic piece of equipment except for the number wheels, rotor and reduction gears. The hourmeter should operate whenever the engine is running. If the hourmeter is intermittent or fails to operate, check for faulty wiring or connections. Check for proper voltage at meter terminal (8 to 32 Vdc). To check accuracy observe the running indicator flag wheel. The gauge is accurate to ±1 percent at 75 °F (24 °C).

a. Removal of the Hourmeter

1. Refer to paragraph 10.8.1 for removal of gauge cluster.
2. Disconnect spade connector at hourmeter (7, Fig. 10.47).
3. To remove hourmeter, loosen nut on clip which secures hourmeter to gauge mounting plate (3).
4. Lift hourmeter from gauge mounting plate.

b. Cleaning and Drying

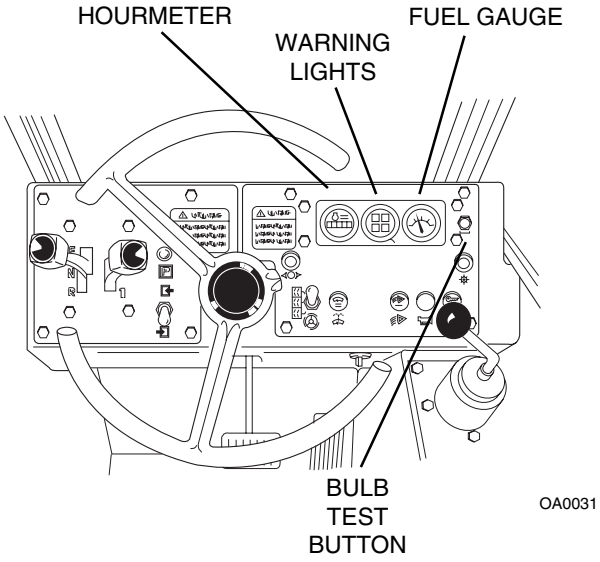
Clean the hourmeter with a clean lint-free cloth.

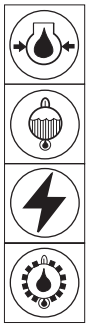
c. Inspection and Replacement

Inspect the hourmeter and replace if defective. To check operation observe the indicator flag wheel.

d. Installation of the Hourmeter

1. Position hourmeter (7, Fig. 10.47) in gauge mounting plate
2. Install clip and nut which secures hourmeter to gauge mounting plate.
3. Refer to paragraph 10.8.2 for installation of the gauge cluster.





Engine Oil Pressure—Indicates low engine oil pressure.

Engine Water Temperature—Indicates high coolant temperature.

Alternator Charging—Indicates alternator is not charging.

Transmission Oil Temperature—Indicates high transmission Oil Temperature.

Fig. 10.48 Warning Lights Signal Dangerous Operating Conditions

10.8.4 Warning Lights

Warning lamps indicate:

- low engine oil pressure,
- high engine coolant temperature,
- alternator is not charging,
- and high transmission oil temperature.

When ignition key is turned to RUN, engine low oil pressure and alternator charge lamps will light. This is normal. When engine is running all lights should be OFF. If a lamp lights, an emergency condition exists; stop forklift as soon as possible and correct the indicated condition.

At the right of the gauges is a warning bulb test button. With ignition key in RUN position and engine OFF, press this button to test all four warning lights. If a bulb fails to light, replace it immediately. You will find the bulb number in the Specifications Table at the end of this section.

a. How to Test the Warning Light Gauge Bulb Test Switch

1. Prepare to test the bulb test switch (10, Fig. 10.47) by disconnecting the wiring at switch.
2. Use an ohmmeter or a continuity tester to test switch for continuity in the depressed TEST position and for a short in the released OFF position.
3. Replace the switch if it fails the test in step 2.

b. How to Replace Bulbs in Warning Light Gauge

1. Turn ignition key to RUN and press bulb test button, Fig. 10.48. Note which bulbs fail to light.

NOTE: If forklift has an optional lighting system, turn on headlights momentarily to see if bulb (16, Fig. 10.47) in fuel level gauge lights. You may have to move the forklift to a dark environment to observe if this bulb lights. If it doesn't light, refer to paragraph 10.8.9 for fuel level gauge instructions. Then continue with step 4 of this procedure.

2. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
3. Remove the four bolts (12, Fig. 10.47) which secure the right console panel and overlay to the cab and lift and tilt the panel to gain access to the back side of the panel.
4. Grasp and turn the appropriate bulb socket (13) a few degrees counterclockwise and remove socket from gauge.
5. Press and turn bulb counterclockwise to release it from socket.
6. Inspect socket contact areas for corrosion and clean and brighten any corroded areas; replace components as required.
7. To install a new bulb, align pins on bulb with channels in socket, push bulb into socket, turn it clockwise to lock pins in detents, and release it; bulb should be securely anchored in socket.
8. Position socket in gauge and turn socket a few degrees clockwise to lock in place.
9. Lower the right console panel into position and install the four bolts (12) which secure the panel to the cab.
10. Connect negative (–) cable to the batteries.
11. Turn ignition key to RUN and press TEST button (10). All four warning bulbs should light.
12. Turn ignition key to OFF and remove key from switch.

c. Removal of Warning Lights Gauge

1. Refer to paragraph 10.8.1 for removal of gauge cluster.
2. Tag and disconnect connector from warning lights gauge.
3. To remove warning lights gauge, remove nut (18, Fig. 10.47), lock washer (19) and clip (20) and remove warning lights gauge from gauge mounting plate (3).

d. Cleaning and Drying

Clean warning lights gauge with a clean lint-free cloth.

e. Inspection and Replacement

Inspect warning lights gauge; replace if required.

f. Installation of Warning Lights Gauge

1. Position warning lights gauge (8, Fig. 10.47) in gauge mounting plate (3).
2. Install clip (20), lock washer (19) and nut (18) to secure gauge (8) to gauge mounting plate (3).
3. Install connector (15) on gauge (8).
4. Refer to paragraph 10.8.2 for the installation of the gauge cluster.

10.8.5 Engine Low Oil Pressure Sender

The engine low oil pressure light warns the operator to discontinue forklift operation immediately because engine oil pressure is too low.

The engine low oil pressure light in the warning lights gauge is described in paragraph 10.8.5. The engine low oil pressure sender for this light (1) is shown in Fig. 10.42.

The oil pressure warning bulb lights to warn the operator to discontinue forklift operation immediately when engine oil pressure falls below 8.7 psi (0,6 bar). Battery voltage is applied to one side of the bulb and a ground path is provided by the engine low oil pressure sender. The bulb will also light momentarily due to low oil pressure when the ignition key is turned to start the engine. After the engine starts and builds normal oil pressure, the sender opens and the light goes out.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Unlock and open right engine access door.
3. Tag and disconnect wire from terminal of low oil pressure sender, Fig. 10.42.
4. Remove low oil pressure sender.

b. Disassembly

Do not disassemble the engine low oil pressure sender.

c. Cleaning and Drying

Without submerging sender, clean sender as required by using a fiber bristle brush and an approved solvent.

d. Inspection and Replacement

1. Check engine oil level before testing sender. Correct low oil level condition.
2. Test the sender for continuity while installed on engine. With wire disconnected from sender terminal, connect an ohmmeter or continuity tester between the sender terminal and a ground point. Continuity should be present. Connect wire to terminal on sender and start the forklift. If warning light remains ON after pressure has built up in the engine, the sender is defective.
3. Replace the sender if it fails to pass the tests in step 2.

e. Installation

1. Install low oil pressure sender.
2. Connect wire to terminal of low oil pressure sender.
3. Connect negative (–) cable (2, Fig. 10.38) to batteries.
4. Start engine and inspect installation for oil leaks.
5. Close and lock right engine access door.

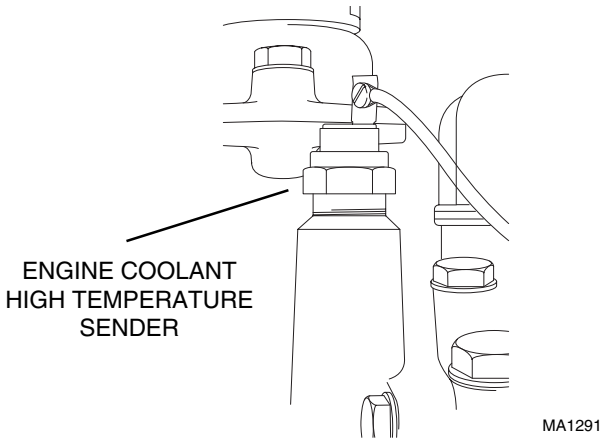


Fig. 10.49 Engine Coolant High Temperature Sender

10.8.6 Engine Coolant High Temperature Sender

The engine coolant temperature light warns the operator to discontinue forklift operation immediately when engine coolant is too hot.

When ignition switch is in RUN position, current through the bulb can be grounded through the coolant high temperature sender. The sender closes when the coolant temperature exceeds 210 °F (99 °C) and the bulb lights.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Unlock and open right engine access door.

IMPORTANT: *Drain engine coolant below the level of the high temperature sender, Fig. 10.49.*

3. Tag and disconnect wire from high temperature sender terminal, Fig. 10.49.
4. Remove high temperature sender.

b. Disassembly

Do not disassemble high temperature sender.

c. Cleaning and Drying

Without submerging the sender, clean the sender as required by using a fiber bristle brush and an approved cooling system cleaner.

d. Inspection and Replacement

Test the sender by connecting a low voltage dc power supply and a test lamp to the sender and suspending its probe in engine coolant which is several degrees below 210 °F (99 °C). The sender should remain open. It should close when coolant exceeds this temperature.

e. Installation

1. Install high temperature sender.
2. Connect wire to terminal of engine coolant high temperature sender.
3. Add engine coolant to normal operating level.
4. Connect negative (–) cable (2, Fig. 10.38) to the batteries.
4. Operate engine and check for coolant leaks.
5. Close and lock right engine access door.

10.8.7 Alternator Not Charging Light

The alternator not charging light warns the operator to discontinue forklift operation immediately due to a malfunction in the battery charging circuit. Wire number 6 from the alternator is energized and lights the alternator not charging bulb if the alternator stops supplying current upon demand by the charging circuit.

Refer to paragraph 10.8.4 for procedure for replacing indicator lamp.

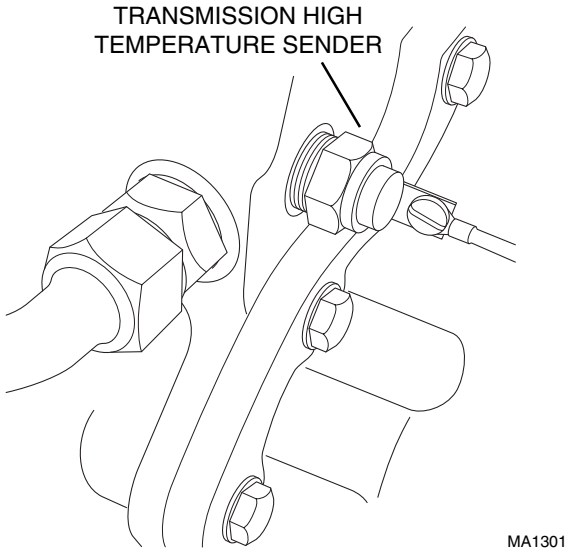


Fig. 10.50 Transmission High Temperature Sender

10.8.8 Transmission High Temperature Sender

The transmission high temperature light warns the operator to discontinue forklift operation immediately because the fluid in the transmission is too hot.

When the ignition key is in RUN, current through the bulb can be grounded through the transmission high temperature sender. The sender closes when the fluid temperature exceeds 250 ± 5 °F (99 ± 3 °C) and the bulb lights.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from batteries.
2. Remove transmission cover.
3. Tag and disconnect wire from high temperature sender terminal, Fig. 10.50.
4. Remove high temperature sender.

b. Disassembly

Do not disassemble the transmission high temperature sender.

c. Cleaning and Drying

Without submerging the sender, clean the sender as required by using a fiber bristle brush and an approved solvent.

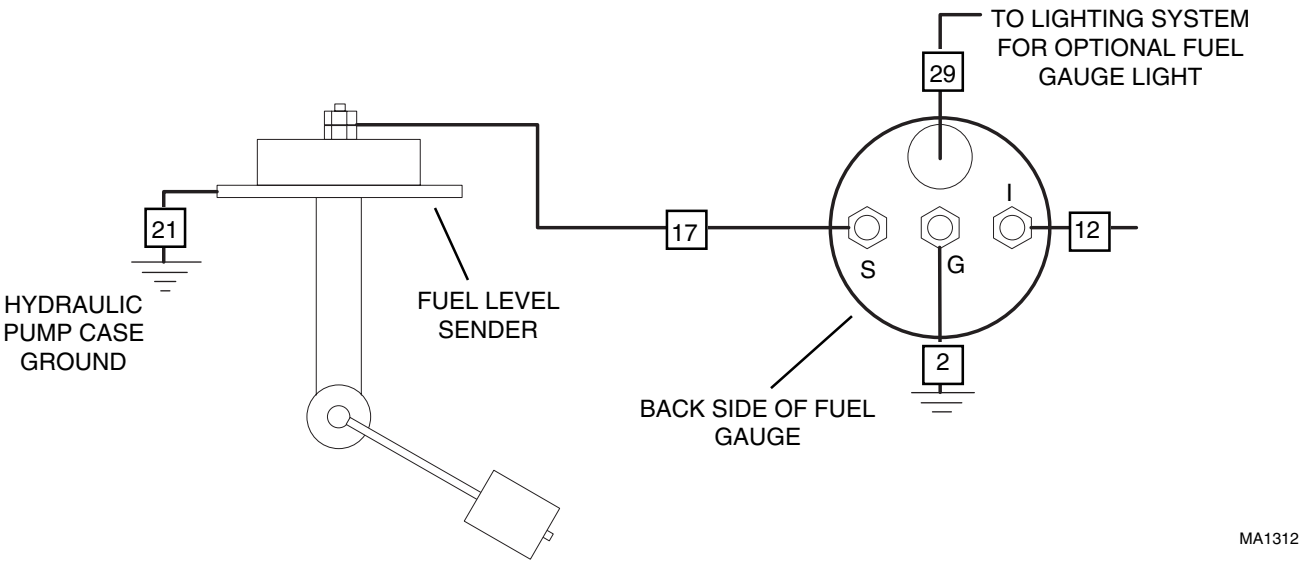


Fig. 10.51 Fuel Lever Sender and Fuel Gauge Schematic

d. Inspection and Replacement

Test the sender by suspending its probe in hydraulic fluid which is at least 10 °F (5 °C) below 250 °F (99 °C). The sender should remain open. Increase the temperature of the fluid until it exceeds this temperature by 10 °F (5 °C). The sender should close.

e. Installation

1. Install the transmission high temperature sender.
2. Connect wire to terminal of transmission high temperature sender.
3. Connect negative (–) cable (2, Fig. 10.38) to batteries.
4. Operate engine and check transmission for fluid leaks.
5. Install transmission cover.

10.8.9 Fuel Gauge

The fuel gauge indicates the liquid level in the fuel tank. It consists of a resistance, float type fuel level sender, Fig. 10.51, mounted in the top of the fuel tank and a fuel level gauge in the control console. The resistance range of the submerged coil type fuel sender is 0-30 ohms.

The pointer of the fuel gauge is moved by the magnetic field of two coils. The coils are at right angles to each other. Battery voltage is applied to the “E” coil and the circuit divides at the opposite end of this coil. One path continues to ground through the “F” coil. Another goes to ground through the variable resistor of the fuel level sender.

When the tank is low, the resistance of the sender is low. A large flow of current passes through the “E” coil and the fuel level sender resistor. This moves the pointer toward “E” on the scale. When the tank is full the sender resistance is high. More current flows through the “F” coil, moving the pointer toward “F” on the scale.

With two coils operating the pointer, the gauge is not affected by changes in the voltage of the system.

a. Fuel Gauge Testing

1. With five gallons of fuel in the fuel tank, fuel gauge needle must be at approximately 1/4 full.
2. Use a jumper wire to jump across the two wires at the fuel level sender on the fuel tank. Fuel gauge needle must be at FULL mark.
3. Switch ignition key OFF; needle must drop below EMPTY.

If a fuel gauge malfunctions, perform the following checks:

1. Check for loose gauge mounting screws, defective wiring, faulty grounds, and corrosion on fuel tank ground connection.

2 If pointer in gauge does not move when ignition key is turned ON, use a test lamp to see if current is flowing from the ignition switch to the terminal on the gauge. Also, be sure paint or corrosion doesn’t prevent proper ground. If pointer still doesn’t move, gauge is defective and must be replaced.

3. If gauge doesn’t indicate fuel level in tank, be sure gauge is 0-30 ohm, 12 V.

4. If gauge shows no indication, look for an empty fuel tank, no current to ignition terminal because of broken or disconnected lead, grounded wire between sender and gauge, gauge not grounded, or sender defective.
5. Excessive pointer fluctuation may be caused by loose wire connections or defective sender.
6. “Full” scale reading at all times may occur if wire to sender is broken, sender is not properly grounded, of if sender is defective.
7. If gauge indicates inaccurately, sender may be defective or there may be low voltage at gauge terminals.
8. If the pointer fluctuates when optional head lights are turned on, the engine is not properly grounded.

b. Fuel Gauge Bulb Replacement

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Remove four bolts (12, Fig. 10.47) which secure the right console panel (5) and overlay to the cab and lift and tilt panel to gain access to the back side of the fuel gauge.
3. Tilt and lift the socket from the fuel gauge.
4. Press and turn bulb (16) counterclockwise to release it from socket.
5. To install a new bulb, align pins on bulb with channels in socket, push bulb into socket, turn it clockwise to lock pins in detents, and release it; bulb should be securely anchored in socket.
6. Position and push socket until it seats in gauge.
7. Lower right console panel (5) into position and secure the panel with four bolts (12).

c. Removal of Fuel Gauge and Sender

Removal of Fuel Gauge

1. Refer to paragraph 10.8.1 for the removal of the gauge cluster.
2. Remove the nut and wire from the right (IGN) terminal post, Fig. 10.52.

IMPORTANT: *Do not touch this wire to the left (SEND) terminal post on the fuel gauge or the sender capsule will be damaged.*

3. Remove the nut and wire from the left (SEND) terminal post of the fuel gauge.
4. Remove the nut and ground wires from the center (GND) terminal post of the fuel gauge.
5. Loosen the nuts on the clip which secures the gauge to the gauge mounting plate.
6. Lift the gauge from the gauge mounting plate.
7. Connect negative (–) cable to batteries.

Removal of Sender

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Remove the nut and wire from the center terminal on the sender.
3. Remove the screw which secures the ground wire and sender to the fuel tank and remove the ground wire.
4. Remove the other four screws which secure the sender to the fuel tank.
5. Carefully remove the sender from the fuel tank by lifting and tilting the assembly so the float and lever clears the opening in the fuel tank.
6. Remove and discard the gasket.

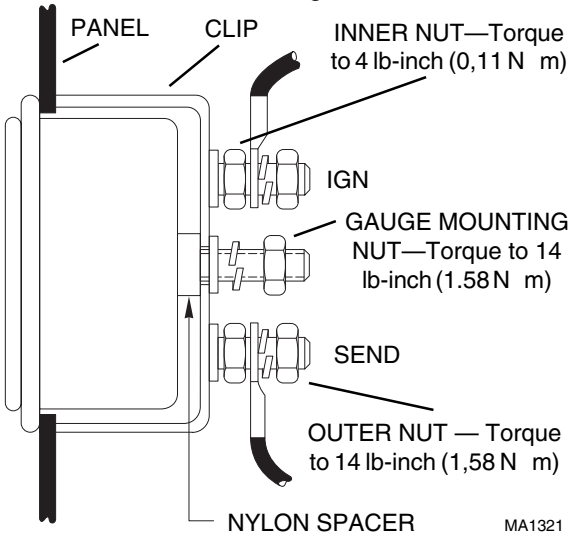


Fig. 10.52 Top View of Fuel Level Gauge

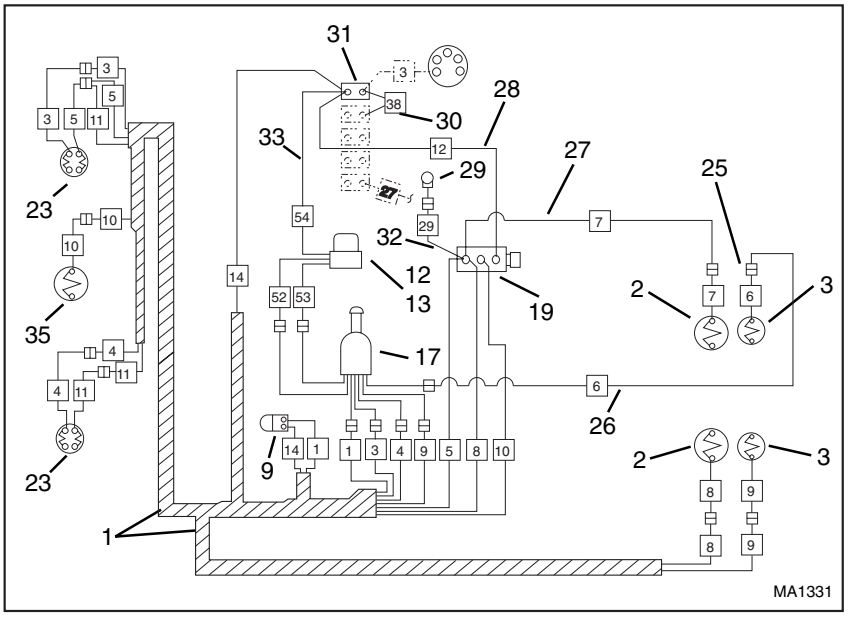
d. Installation of Fuel Gauge and Sender

Installation of Fuel Gauge

1. Position fuel gauge in gauge mounting plate (3, Fig. 10.47).
2. Install clip and nuts which secure gauge to gauge mounting plate.
3. Install the nut and ground wires on the center (GND) terminal post of the gauge.

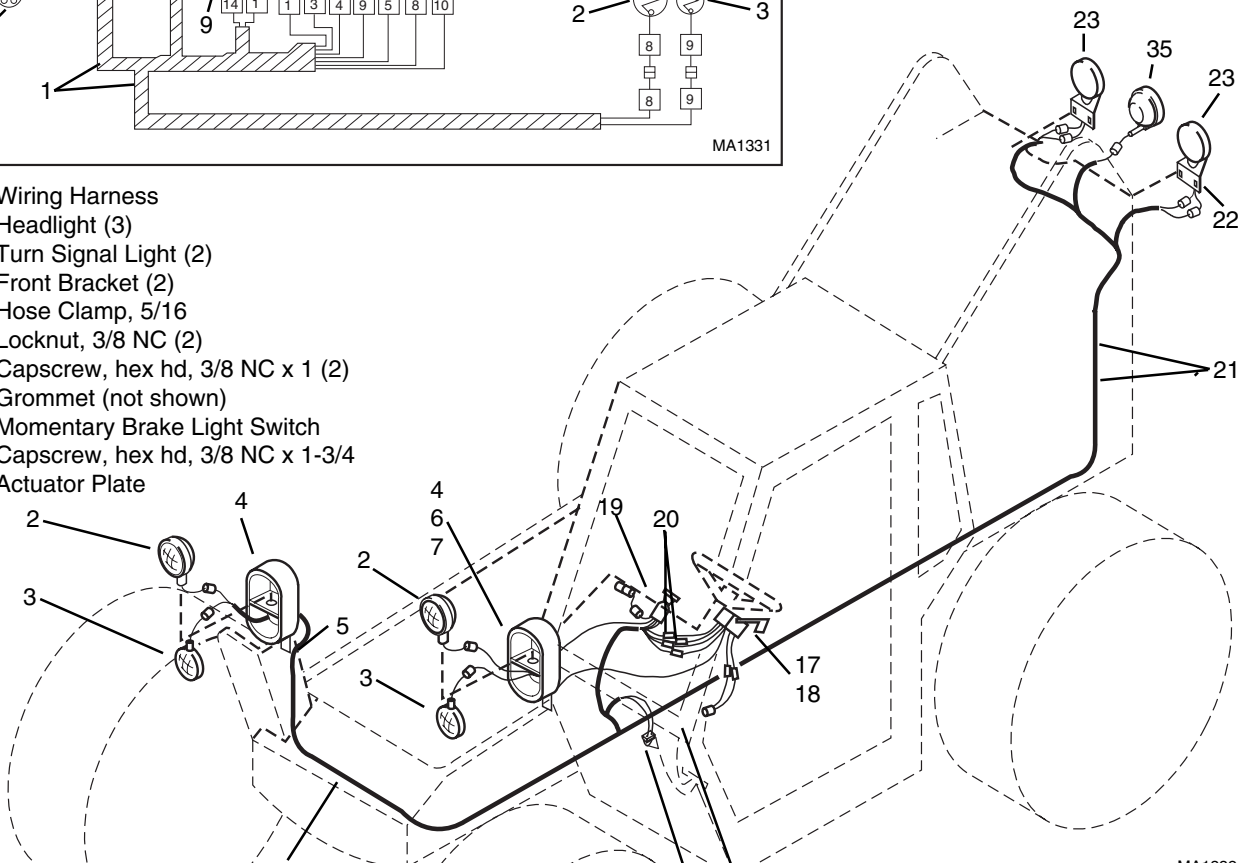
IMPORTANT: *Torque inner nuts to 4 lb-inch (0,45 N m) and outer nuts to 14 lb-inch (1.6 N m) on the terminal posts of the fuel gauge.*

4. Install the nut and wire on the left (SEND) terminal post of the gauge.



8 IS A GROMMET (NOT SHOWN)

24 IDENTIFIES FOUR PLASTIC TIES (NOT SHOWN)



1. Wiring Harness
2. Headlight (3)
3. Turn Signal Light (2)
4. Front Bracket (2)
5. Hose Clamp, 5/16
6. Locknut, 3/8 NC (2)
7. Capscrew, hex hd, 3/8 NC x 1 (2)
8. Grommet (not shown)
9. Momentary Brake Light Switch
10. Capscrew, hex hd, 3/8 NC x 1-3/4
11. Actuator Plate
12. Flasher Mount
13. Flasher
14. Machine Screw, rd hd, #10-24 x 3/4 (2)
15. Locknut, #10-24 (2)
16. Flat Washer, #10 (2)
17. Turn Signal Switch
18. Conduit, 1/2 ID x 12 (not shown)
19. Head Light Switch
20. Terminal, female, 1/4 spade (7)
21. Hose Clamp, 3/8 (2)
22. Tail Light Bracket (2)
23. Stop and Tail Light (2)
24. Plastic Tie, 4 diameter (not shown)
25. Terminal, male, 1/4 spade
26. Wire Assembly
27. Wire Assembly
28. Wire Assembly
29. Fuel Gauge Light Assembly
30. Wire Assembly
31. Circuit Breaker, 15 A
32. Wire Assembly
33. Wire Assembly
34. Jam Nut 3/8 NC
35. Rear Work Light

Fig. 10.53 Schematic of Lighting System

Lighting System Circuits

Use with Fig. 10.53 Lighting System

Wire No.	Color	Gauge	From	To
1	Black	14	Turn Signal Switch (17)	Momentary Brake Switch (9)
2	Black	14	Not Used	
3	Black	14	Turn Signal Switch (17)	Stop and Tail Light (23)
4	Black	14	Turn Signal Switch (17)	Stop and Tail Light (23)
5	Black	14	Headlight Switch (19)	Stop and Tail Light (23)
6	Black	14	Turn Signal Switch (17)	Turn Signal Light (3)
7	Black	14	Headlight Switch (19)	Headlight (2)
8	Black	14	Headlight Switch (19)	Headlight (2)
9	Black	14	Turn Signal Switch (17)	Turn Signal Light (3)
10	Black	14	Headlight Switch (19)	Headlight (2)
11	Black	14	Stop and Tail Light (23)	Stop and Tail Light (23)
12	Black	14	15 A Circuit Breaker (31)	Headlight Switch (19)
13	Not Used			
14	Black	14	15 A Circuit Breaker (31)	Momentary Brake Light Switch (9)
29	Black	14	Headlight Switch (19)	Fuel Gauge Light Assembly (29)
38	Black	14	15 A Circuit Breaker	6 A Circuit Breaker
52	Black	14	Turn Signal Switch (17)	Flasher (13)
53	Black	14	Turn Signal Switch (17)	Flasher (13)
54	Black	14	15 A Circuit Breaker (31)	Flasher (13)

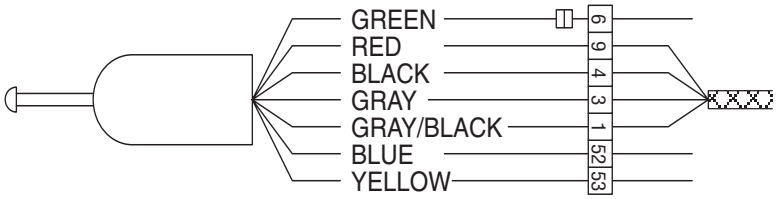


Fig. 10.54 Schematic of Directional Signal and Emergency Flasher Switch

5. Install nut and wire on the right (IGN) terminal post.

IMPORTANT: *Do not touch this wire to the left (SEND) terminal post on the gauge or the sender capsule will be damaged.*

6. Refer to paragraph 10.8.2 for the installation of the gauge cluster.

Installation of the Sender

1. Install a new gasket in the tank opening.
2. Carefully tilt and lower the sender assembly into the fuel tank.
3. Loosely install the screw which secures the ground wire to the sender and fuel tank.
4. Install the other four screws and alternately torque the five screws which secure the sender to the fuel tank from 10 to 14 lb-inch (1,13 to 1,58 N m). Use No. 10-24 screws.
5. Install the wire and nut on the center terminal of the sender.
6. Connect negative (–) cable to the batteries.

10.9 OPTIONAL LIGHTING SYSTEM

The optional lighting system, Fig. 10.53, provides:

- headlights (2), directional signal and hazard warning lights (3) at the front of the forklift;
- directional signal, hazard warning, stop and tail lights (23) and a rear work light (35) at the rear of the forklift, and
- an illuminated fuel level gauge.

The stop lights glow when the brake pedal is pressed. The stoplights are combined with the directional signal lights, emergency flasher lights and tail lights.

Occasionally check to be sure:

- all wiring connections are tight and clean;
- that each lighting unit is tightly mounted to provide a good ground, and
- that the headlights are properly adjusted.

Loose or corroded connections may cause a discharged battery, difficult starting, dim lights, and possible damage to the alternator and charging circuit.

10.9.1 Directional and Emergency Flasher Switch

The directional signal lever and the hazard (emergency flasher) slide controls, Fig. 10.55, are located directly below the steering wheel.

The ignition switch must be in the RUN position for directional signal lights to be operated with the directional signal switch lever.

With the directional signal switch in the neutral position, stepping on the brake pedal will illuminate the rear stop lights on both sides. If directional signals are operating on either side, stepping on the brake pedal will turn on the stop light only on the side which is not flashing.

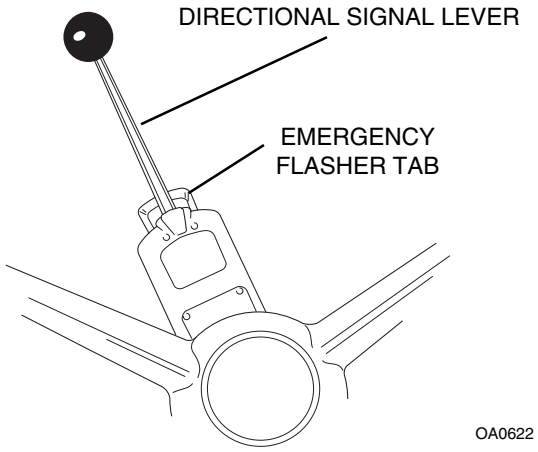


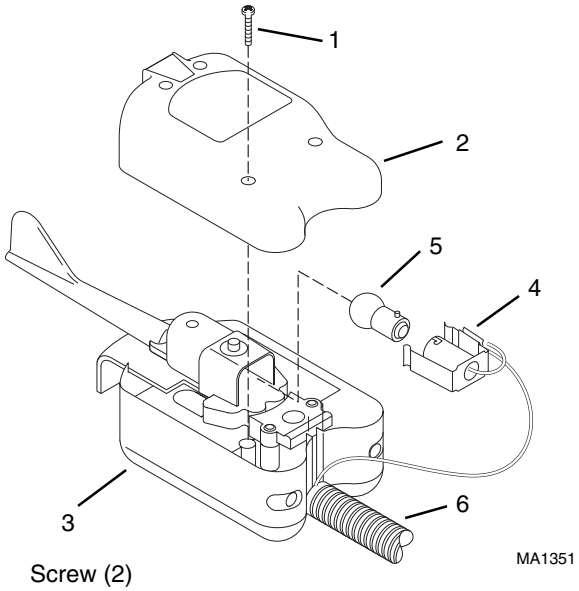
Fig. 10.55 Directional Signal Switch Lever and Emergency Flasher Control Tab

Push the lever of the directional signal switch to the left and down to signal a left turn; to the right and up for a right turn. A green pilot light will flash to indicate proper functioning. If pilot light doesn't flash, check for defective lamp or pilot bulb before checking flasher.

The signals are not self-cancelling; the lever must be moved to the center OFF position after the indicated turn is negotiated.

a. How to Operate the Emergency Flashers

To operate the emergency flashers, pull flasher tab out. All signal lamps and red pilot light will flash. To cancel the emergency flashers, move the directional signal lever momentarily in either direction.



1. Screw (2)
2. Top cover
3. Directional signal switch
4. Spring clip and socket
5. Pilot bulb
6. Wiring harness

Fig. 10.56 Pilot Bulb Replacement

b. Flasher and Pilot Bulb Replacement

To replace the pilot bulb, remove two screws (1, Fig. 10.56) and lift top cover (2) of directional signal switch (3). When cover is removed, pull spring clip (4) away from handle. Remove old pilot bulb (5) and install a new No. 53 bulb for 12 volt service. Engage the spring clip into the handle. Do not try to test pilot bulb until switch is reassembled and grounded.

The flasher mount (12, Fig. 10.53) is located above and to the right of the brake pedal. When replacing a flasher, use Flasher No. 180 for this 12 V system.

c. Switch Removal

1. Remove console cover below steering wheel.
2. Disconnect negative cable (2, Fig. 10.38) from the batteries.
3. Disconnect wiring.
4. Remove screws, anchors, clips, strap and switch.

d. Switch Disassembly

There are no serviceable parts in the switch except the bulbs.

e. Switch Inspection and Replacement

1. If the switch has been in service for a long period of time, prepare to remove the top cover of the switch by removing two screws.
2. Apply silicon lubricant to the switch lever pivot and mechanical contact areas.
3. Replace top cover and two screws.

f. Switch Installation

1. Make sure you disconnect the ground cable (2, Fig. 10.38) from the negative terminals of the batteries and remove the flasher during installation and wiring.
2. Refer to schematic Fig. 10.54 and reconnect the wires.
3. Tape ends of unused wires to prevent shorts.
4. Mount switch on steering column as shown in Fig. 10.57.
5. Insert screws into anchors.

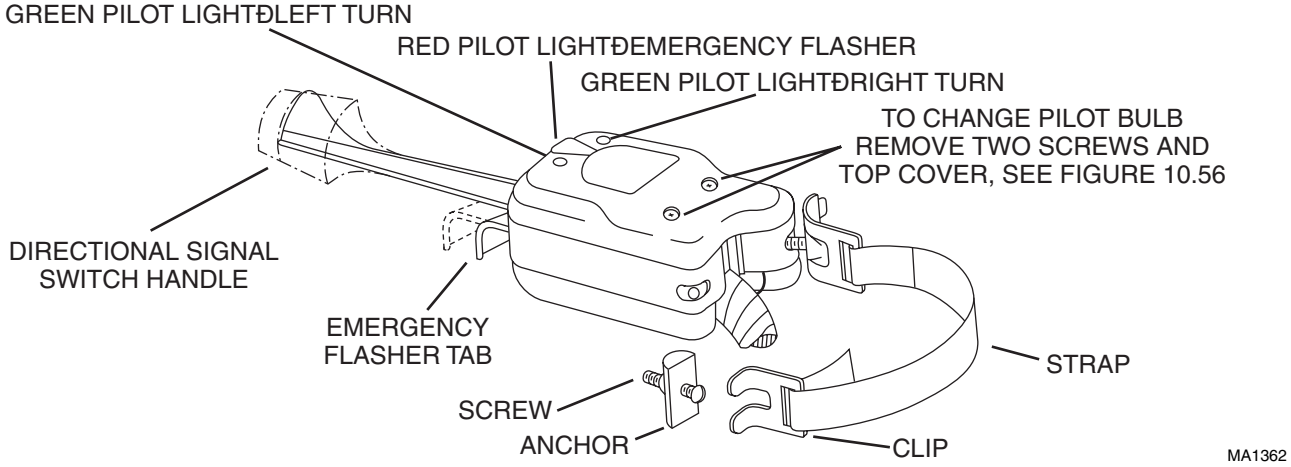


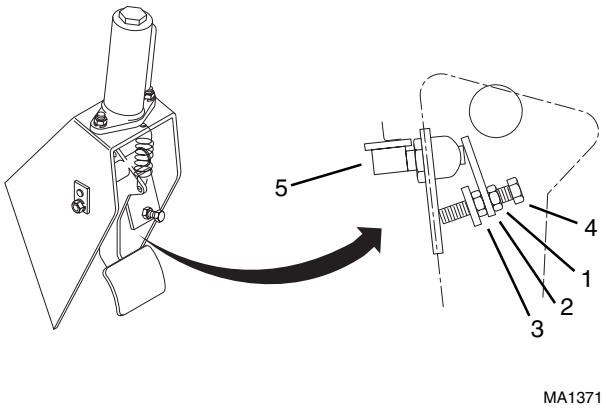
Fig. 10.57 Directional and Emergency Flasher Switch Removal

6. Insert assembled anchor screws into slots in switch. Do not tighten.
7. Bend strap end through and around clip. Engage clip between anchor and switch housing.
8. Hold switch against steering column in desired position and bend strap around column. Scrape paint from column under strap to make ground contact.
9. Estimate strap length required and cut if necessary. Insert unbent portion of strap through other clip and assemble as in step 7.
10. Catch clip under anchor and tighten screws equally until switch is clamped firmly to steering column.
11. Replace flasher and connect negative (–) cable to the batteries.

10.9.2 Momentary Brake Light (Stop Light)

Two stop/tail lights (23, Fig. 10.53) at the rear of the forklift have dual filament bulbs. The brake filament lights as long as the service brake pedal is pressed; it goes out when the pedal is released completely.

Inspect the operation of the stop/tail light daily and replace the bulb whenever either filament fails to light. You will find the number of the bulb in the Electrical Specifications Table at the end of this section.



1. Jam Nut
2. Actuator Plate
3. Jam Nut
4. Capscrew
5. Momentary Brake Light Switch

Fig. 10.58 Momentary Brake Light Switch

10.9.3 Momentary Brake Light Switch

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Loosen jam nut (1, Fig. 10.58) which secures actuator plate (2) to the brake pedal
3. Loosen jam nut (3) which bears against the plate which is welded to the brake pedal.
4. Remove capscrew (4) and actuator plate (2).
5. Prepare to remove the rubber capped mounting nut, hereafter referred to as the “boot,” from the switch (5) by loosening the switch jam nut on the back side of the brake pedal.
6. Remove the boot from the switch by manually turning the boot counterclockwise. Pull and tilt the boot as required to release the boot from the groove in the plunger and remove the boot from the switch.
7. Remove the switch from the brake pedal and carefully lower it to the cab floor without disconnecting the wires.
8. Tag and disconnect the wires.

b. Disassembly

Do not disassemble the momentary brake light switch.

c. Cleaning and Drying

If the switch is to be reinstalled, without submerging the switch clean the switch in an approved solvent and dry it using clean, lint-free cloths.

d. Inspection and Replacement

1. Inspect the switch plunger for freedom of movement.
2. Inspect the boot for pliability and for cracks.
3. The switch is normally ON, push to OFF, release and switch will spring return to ON. Test continuity across the switch terminals with the switch released in the ON position.

e. Installation

1. Refer to the tags attached in paragraph “a” and connect the wires to the switch.
2. Remove the boot from the switch and insert the switch (5, Fig. 10.58) through mounting hole in the brake pedal and secure switch by tightening switch jam nut on the back side of the brake pedal.

3. Work the opening in the boot into the groove of the plunger so the metal of the plunger bears against the actuator plate, not the boot. Proper installation of the boot protects the sliding plunger from contamination.
4. Install jam nut (1) on capscrew (4) and actuator plate (2) on capscrew.
5. Install jam nut (3) on capscrew and then install capscrew in brake pedal.
6. Readjust brake pedal stop position as described in paragraph 4.3.1.
7. With brake pedal in its normal adjusted position the plunger must be depressed approximately 0.12" (3 mm). Adjust the plunger by loosening the switch jam nut and adjust by turning the boot as required to obtain this dimension.
8. Tighten the switch jam nut to maintain this adjustment.
9. Reconnect negative (–) cable to the batteries.

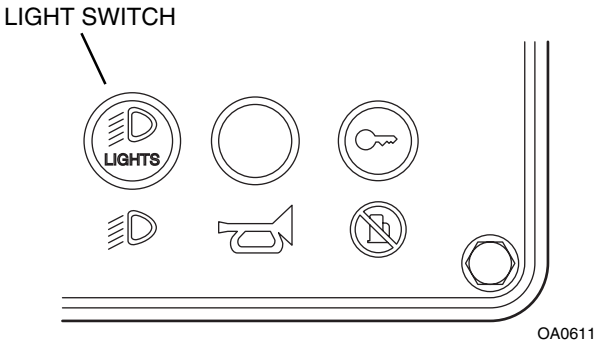


Fig. 10.59 Headlight and Work Light Switch

10.9.4 Headlight and Rear Work Light Switch

The headlights and rear work light are controlled by a three position push-pull switch, Fig. 10.59, on the instrument panel. This switch also controls the headlights, directional signal lights, tail lights and a light in the fuel gauge.

- Switch In: Lights OFF
- Switch Halfway Out: Headlights, Tail Lights and Panel Lights ON
- Switch Fully Out: Headlights, Tail Lights, Panel Lights and Rear Work Light ON

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Prepare to remove the light switch by removing the lower panel which is located below the steering wheel.
3. Tag and disconnect the wires from the switch.
4. Remove the hex nut which secures the switch to the right front console panel.

b. Disassembly

Do not disassemble the switch.

c. Cleaning and Drying

Without submerging the switch, clean the switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity in the switch halfway out and fully out positions and shorting in the switch in position.
2. Replace the switch if it fails the tests in step 1.

e. Installation

1. Connect the wires as they were tagged during switch removal.
2. Position the switch from under the right front console panel.
3. Install switch and hex nut.
4. Install lower console panel.
5. Connect negative (–) cable to the batteries.
6. Test switch in all three positions.

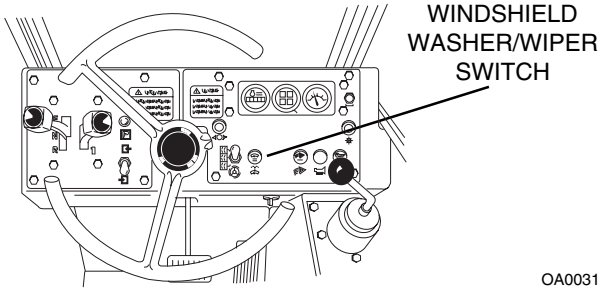


Fig. 10.60 Windshield Washer/Wiper Switch

10.10 WINDSHIELD WASHER/WIPER

10.10.1 Windshield Washer/Wiper Switch (Enclosed Cab Only)

The windshield washer/wiper switch, Fig. 10.60, is supplied on a forklift with an enclosed cab. Turn knob to left to operate wiper at low speed; to right to operate wiper at high speed. Press and hold knob to activate windshield washer The windshield washer fluid tank is located at the right side of the seat.

The 6 A rated switch has a built-in circuit breaker.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Prepare to remove the windshield washer/ wiper switch by removing the lower panel which is located below the steering wheel.
3. Tag and disconnect the wires from the switch.
4. Remove the knob by pulling directly upward on the knob.
5. Remove the hex nuts which secure the switch to the panel.

b. Disassembly

Do not disassemble the switch.

c Cleaning and Drying

Without submerging the switch, clean the switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity with the switch in the right, lift and depressed positions and shorting in the center position.
2. Replace the switch if it fails the tests in step 1.

e. Installation

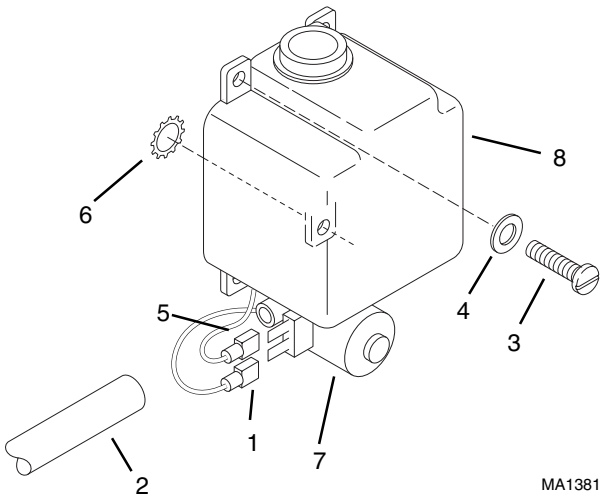
1. Connect the wires as they were tagged during switch removal.
2. Position the switch from under the right front console panel.
3. Install the switch and tighten the hex nut.
4. Replace the knob and lower console panel.
5. Connect negative (–) cable to the batteries.

10.10.2 Windshield Washer Motor and Reservoir (Enclosed Cab Only)

The windshield washer motor and reservoir are a unit and cannot be serviced separately.

a. Removal

1. Disconnect the negative (–) cable at the batteries (2, Fig. 10.38).
2. Disconnect the positive wire (1, Fig. 10.61) at the motor (7).
3. Disconnect the hose (2).
4. Remove three bolts (3), three flat washers (4) and the ground wire (5).



1. Positive Wire
2. Hose
3. Bolt (3)
4. Flat Washers
5. Ground Wire
6. Tooth-Type Lock Washer
7. Motor
8. Washer Reservoir Assembly

Fig. 10.61 Windshield Washer Motor Removal

IMPORTANT: *Be careful to save the tooth type lock washer (6) at the lower right corner of the reservoir between the reservoir and the cab wall.*

5. Lift the washer reservoir assembly (8) from the forklift.

b. Disassembly

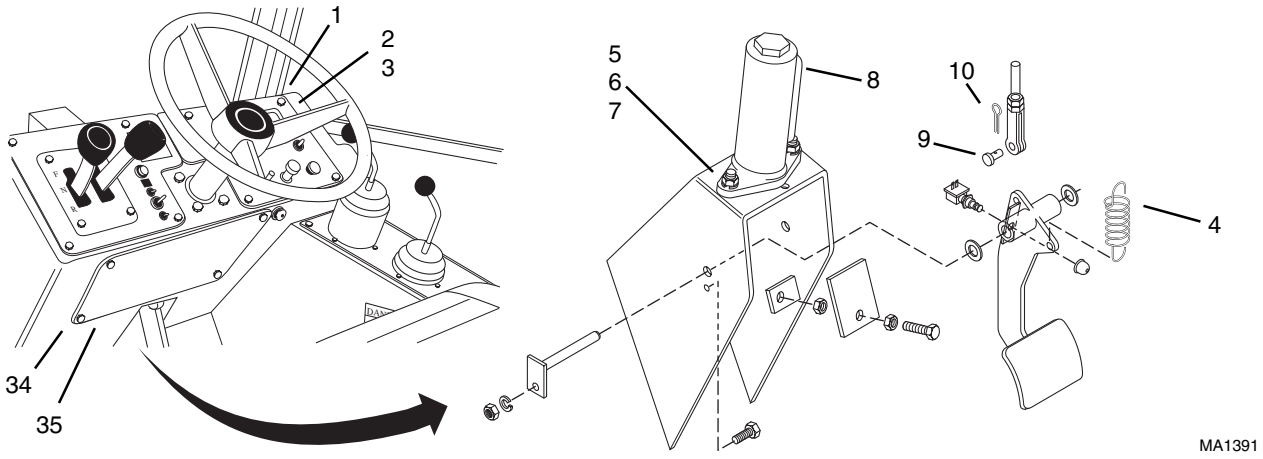
Do not disassemble; the reservoir and motor are not available separately.

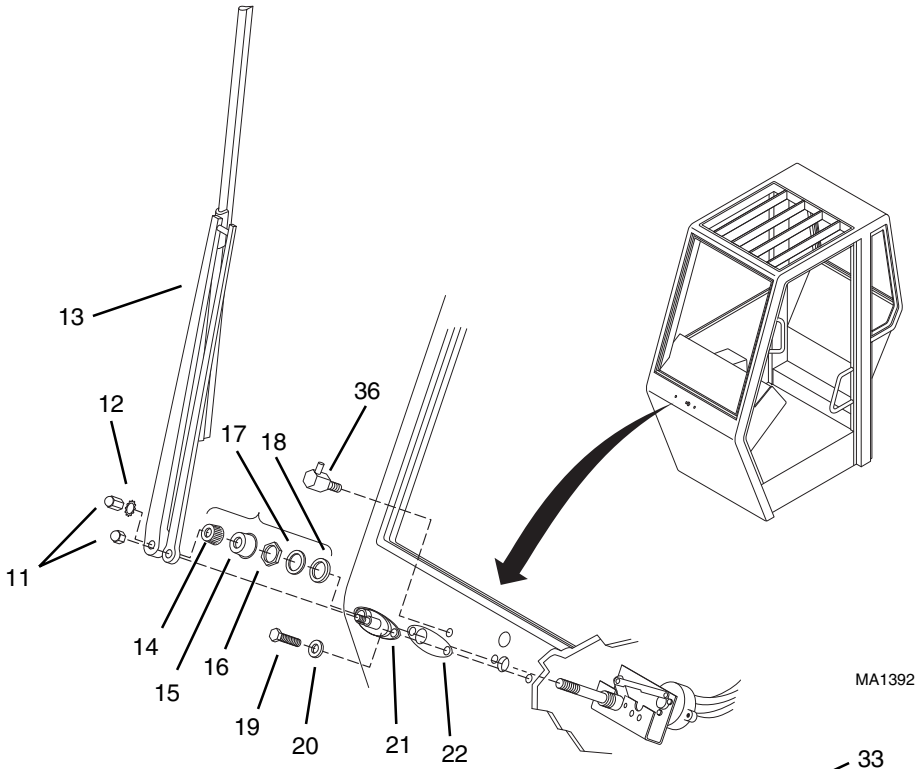
c. Cleaning and Drying

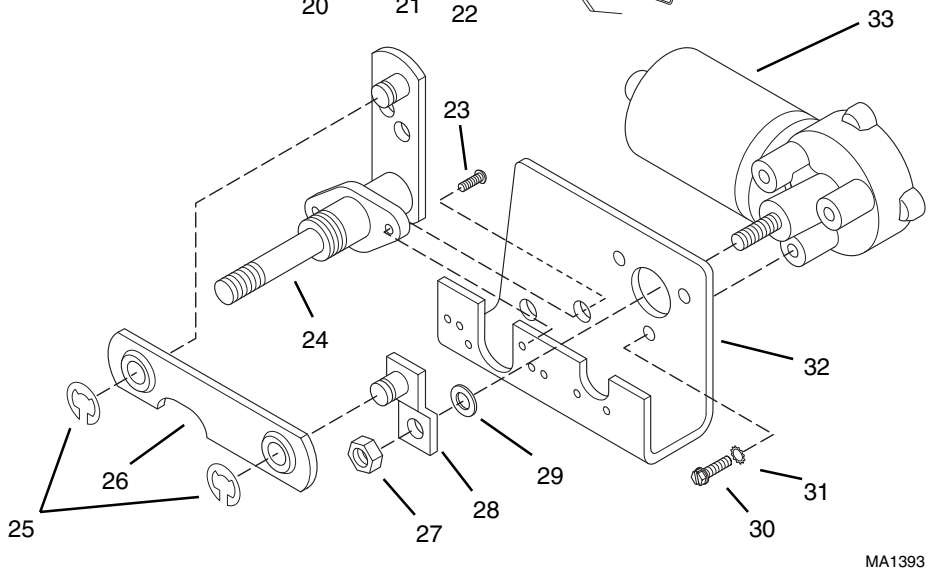
Without submerging the motor or pump, rinse out the reservoir and allow it to air dry.

d. Inspection and Replacement

1. Prepare to test the motor by filling the reservoir with water.
2. Test the motor by connecting a 12 Vdc source to the motor terminals. If motor doesn't run, replace reservoir and motor assembly.
3. Inspect the condition of the reservoir; if cracked, brittle, or leaking at the joint between the reservoir and pump, replace the reservoir and motor assembly.
4. Check hose from pump to washer nozzle for proper connection and deterioration.
5. Be sure passage through nozzle is open and is not clogged.







1. Flange Head Capscrews (4)
2. Right Console Overlay
3. Right Front Console Panel
4. Spring
5. Jam Nuts (2)
6. Lock Washers (4)
7. Capscrews (2)
8. Brake Valve
9. Clevis Pin
10. Cotter Pin
11. Nut
12. Washer
13. Wiper Arm
14. Knurled Driver
15. Rubber Cap
16. Nut
17. Washer
18. Fiber Washer
19. Screw (2)
20. Flat Washer (2)
21. Panto Adapter
22. Gasket
23. Nut
24. Shaft and Pivot Assembly
25. Retainer
26. Connecting Link
27. Nut
28. Drive Arm
29. Bowed Washer
30. Screw
31. Lock Washer
32. Motor Mount
33. Wiper Motor
34. Capscrew
35. Lower Panel
36. Washer Nozzle

Fig. 10.62 Windshield Wiper Motor Removal and Disassembly

e. Installation

1. Prepare to install washer reservoir assembly by taping a tooth-type lock washer (4, Fig. 10.61) to back side of the lower right corner of reservoir. Use a thin transparent tape.
2. Position reservoir assembly (8) in the forklift.
3. Install two flat washers (4) and two bolts (3) through the holes in the top of the reservoir.
4. Install the ground wire (5), flat washer (4), bolt (3) through the hold in the lower right corner of the reservoir. The bolt will pass through the tooth-type lock washer (4) which was taped to the reservoir in step 1.
5. Connect the hose (2).
6. Connect the positive wire (1) to the motor.
7. Connect negative (–) cable to the batteries.

10.10.3 Windshield Wiper Motor (Enclosed Cab Only)

The windshield wiper motor is located behind the steering column and brake valve.

Caution !

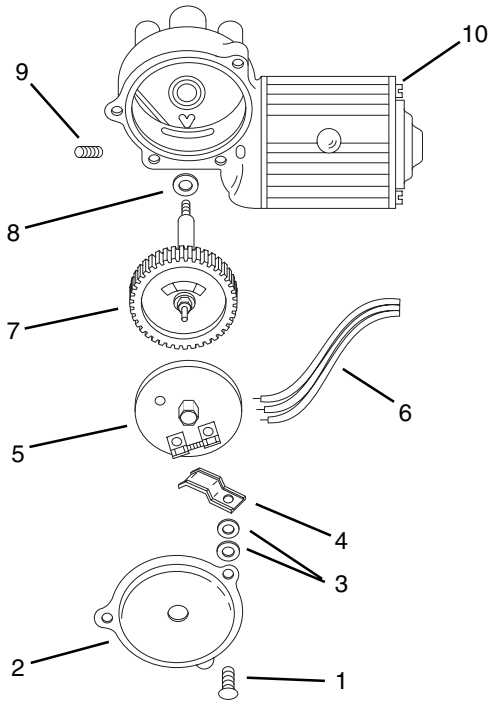
Keep hands away from linkage when motor is operating to avoid serious personal injury.

a. Initial Testing

1. If the motor fails to operate, prepare to test the motor by disconnecting the negative (–) cable from the batteries.
2. Disconnect the wiring to the motor and test the motor using an independent 12 Vdc power source which supplies at least 6 A.
3. Reconnect the negative (–) cable to the batteries.
3. If the motor fails to operate, remove and replace the motor as follows.

b. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Prepare to remove the windshield wiper motor by removing four flange head capscrews (1, Fig. 10.62) and lifting and positioning the right console overlay (2) and right front console panel (3) to one side to provide access to the windshield wiper motor.
3. Tag and disconnect wiring from wiper motor.
4. Prepare to position the brake valve (8, Fig. 10.62) to one side by disconnecting spring (4).
5. Remove two jam nuts (5), four lock washers (6) two capscrews (7) and position the brake valve (8) out of the way to provide access to the windshield wiper motor.
6. Remove nuts (11) and washer (12).
7. If necessary, use a gear puller to separate wiper arm (13) from knurled driver (14). Then remove knurled driver.
8. Remove rubber cap (15), nut (16), washer (17) and fiber washer (18).
9. While an assistant supports the windshield wiper motor from within the cab, remove the screw (19), flat washer (20), panto adapter (21), and gasket (22); your assistant can now lift the motor and attached parts from the cab.
10. Place motor and attached parts on a bench and remove nut (27), drive arm (28) and washer (29) from wiper motor assembly (33).



A. Torque from 18 to 22 lb-inch (2.03 to 2.49 Nm)
1. Screw (3)
2. Cover
3. Spacing Washers
4. Cable Securing Bracket
5. Parking Switch Assembly
6. Cable Assembly
7. Gear and Shaft Assembly
8. Spacing Washer
9. Automatic Wiper Parking Adjustment Stud
10. Wiper Motor

Fig. 10.63 Wiper Motor Disassembly

c. Disassembly

1. To facilitate reassembly, place parts on a clean bench or in a clean pan in the order in which they are removed.
2. Remove cover fastening screws (1, Fig. 10.63), cover (2), spacing washers (3), and cable securing bracket (4) from the gear housing.
3. Remove parking switch assembly (5). If the parking switch is to be replaced, unsolder all leads from the plate.
4. Remove cable assembly (6) if replacement is necessary.
5. Remove gear and shaft assembly (7) and spacing washer (8) from the drive shaft.

NOTE: If drive gear housing or motor housing is damaged beyond repair, replace motor assembly.

d. Cleaning and Drying

1. Clean the gear and shaft assembly (7) and the armature shaft worm with Varsol or equivalent cleaning fluid.

IMPORTANT: *Bearing equipped parts* ***must not*** *be immersed in the cleaning fluid. These parts should be cleaned with a brush dipped in the cleaning fluid, making certain that the cleaning fluid does not contact the bearings.*

2. Thoroughly dry all parts that have been in contact with the cleaning fluid.
3. Clean the parking switch using a clean dry cloth. Remove all traces of lubricant from the contact spring and grease or oil from the insulation plate.

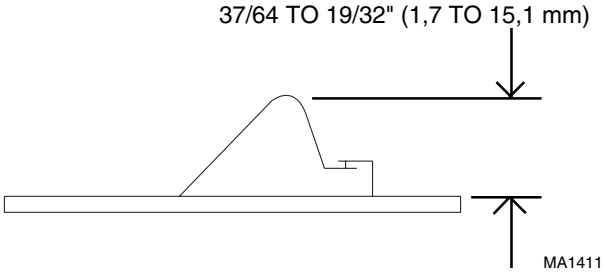


Fig. 10.64 Minimum and Maximum Parking Switch Spring Dimensions

e. Inspection and Replacement

1. Inspect parking switch assembly (5, Fig. 10.63) for security of soldered connections, cracked or damaged plate, loose terminals, damaged or frayed cables, loose parking stud, and misaligned contact points. Spring height must be as indicated in Fig. 10.64.
2. Inspect gear and shaft assembly (7) for damaged or worn gear teeth, damaged threads or worn flats on the end of the shaft. Replace gear and shaft assembly if damaged.
3. Replace motor if motor housing is damaged.
4. Inspect drive arm assembly (28, Fig. 10.62) for wear, loose pin and cracks. Replace drive arm assembly if damaged.
5. Inspect connecting link (26) for worn bearings. Replace connecting link if damaged.
6. Inspect shaft and pivot assembly (24) for damaged threads and loose drive arm. Replace damaged parts.
7. Inspect spring clips, screws, nuts and washers for serviceability. Replace as required.

f. Lubrication

As the parts are being assembled:

1. Lubricate the gear housing by filling the space between the bearings in the drive shaft bore with Electro Systems LU3001 grease.
   - Place a sufficient amount of grease in the worm gear cavity to immerse the lower 1/8" of the drive gear.
   - Apply a thin film of LU3001 grease to the portion of the housing that contacts the drive gear. Apply two or three drops of SAE #10 oil to the felt packing surrounding the armature shaft bearing.
2. Lubricate the gear and shaft assembly (7, Fig. 10.63) by applying a thin film of Electro Systems TSE52115 to the cam and recessed portion of the gear face. Apply a thin film of Electro Systems LU3001 grease to both sides of the nylon spacing washer (8).

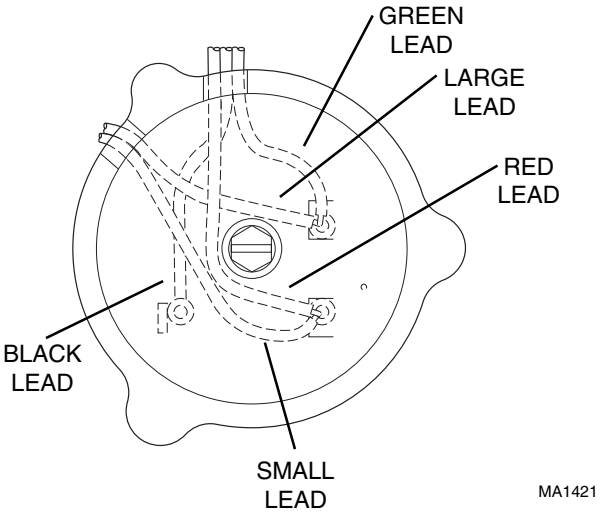


Fig. 10.65 Soldering of Coil Leads and Cable Assembly to Windshield Wiper Parking Switch

g. Reassembly

1. Solder the coil leads and cable assembly to the parking switch as shown in Fig. 10.65.
2. Assemble the spacing washer (8, Fig. 10.63) to the drive shaft, and the gear and shaft assembly (7) to the gear housing with the flats on the drive shaft coinciding with the horizontal center line of the motor. Complete step 1 of paragraph f, Lubrication.
3. Assemble the bowed washer (29, Fig. 62) to the drive shaft with the convex surface facing the gear housing. Assemble the drive arm (28) and nut (27) to the drive shaft.

IMPORTANT: *Hold the drive plate in a vise to prevent placing a strain on the gear teeth when tightening the nut.*

4. Tighten the nut to a torque of 50 to 70 lb/in (5,6 to 7,9 N m).

h. Testing

1. Connect the negative terminal of a fully charged 12 V battery, depending upon the rated voltage of the motor, to one of the thrubolts (10, Fig. 10.63).
2. Test high speed operation by connecting the red lead to the positive terminal. The output shaft will turn at 60 to 75 rpm with a maximum current draw of 3 A.
3. Test low speed operation by connecting the green leads to the positive terminal. The output shaft will turn at 45 to 58 rpm with a maximum current draw of 2 A.

i. Wiper Blade Park Adjustment

Caution !

Keep hands away from linkage whenmotor is in operation to avoid serious personal injury.

After a windshield wiper drive unit has been installed in a vehicle, but before the arm and blade are assembled to the drive arm (28, Fig. 10.62), adjust blade park position as follows:

IMPORTANT: *The arm and blade should* ***not*** *be assembled to the drive arm (28) at this time.*

1. Operate the motor through the manual switch.
2. Watch the drive collar on the wiper arm shaft assembly. Turn the switch to the OFF position and note the park position of the drive collar.

NOTE: The parking position of the drive collar must be at the end of a complete oscillation.

3. If adjustment is required to obtain the proper parking position, proceed as follows:
   (a) Loosen the cover fastening screws (1, Fig. 10.63).
   (b) If the drive collar parks before completing an oscillation, turn the adjustment stud counterclockwise.
   (c) If the drive collar parks after it has completed an oscillation and has started the return swing, move the adjustment stud (9, Fig. 10.63) clockwise.
   (d) Start the motor, shut it off and note the new parking position of the drive collar.
   (e) Repeat the procedures in paragraphs 3b, c, and d until the required parking position is obtained, then tighten the cover fastening screws (1) to a torque of 18 to 22 lb/in (2 to 2,5 N m).
4. Install wiper arm and blade in park position.
5. Operate the wiper and note the park position of the blade when the unit is turned off.
6. If the blades don't park in the required position, readjust as described in step 3.

NOTE: Never adjust the arm and blade to park closer than 1-1/2 to 2" from the windshield moulding. The wipe angle of a 18" arm with a 18" blade should not exceed 127°.

j. Installation

1. Attach the motor (33, Fig. 10.62) to the motor mount (32) using three lock washers (31) and capscrews (30).
2. Install the drive arm (28) and nut (27) on the gear and shaft assembly (7, Fig. 10.63).
3. While an assistant supports the windshield wiper motor from within the cab, install the gasket (22, Fig. 10.62), panto adapter (21), flat washer (20) and screw (19).
4. Connect the wiring to the wiper motor.
5. Install the fiber washer (18), washer (17), nut (16), and rubber cap (15).
6. Install wiper arm (13) on knurled driver (14).
7. Install washer (12) and nut (11).
8. Connect wiring to wiper motor.
9. Position the brake valve (8) and install two capscrews (7), four lock washers (6) and two jam nuts (5).
10. Install clevis pin (9) and cotter pin (10).

11. Connect spring (4).
12. Position the right front console panel (3) and right console overlay (2) and install four flange head capscrews (1).
13. Connect the negative (–) cable (2, Fig. 10.38) to the batteries.

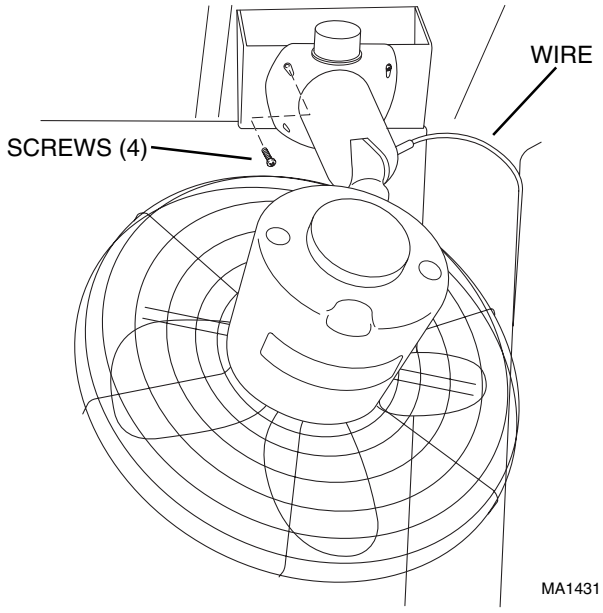


Fig. 10.66 Air Circulation Fan Removal

10.11 FAN SWITCH AND FAN MOTOR (OPTIONAL)

The circulation fan is only operable when the ignition switch is in the RUN position. The fan switch is located at the base of the fan mount.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38), from the batteries.
2. Disconnect wire, Fig. 10.66, from fan at terminals.
3. Support the fan with one hand and remove four screws with the other hand.

b. Disassembly

Do not disassemble; there are no serviceable parts in the fan.

c. Cleaning and Drying

Without submerging motor or bearings, clean fan with a nonmetallic bristle brush using an approved solvent and dry with a clean cloth.

d. Inspection and Replacement

Test fan using a 12 Vdc source which supplies at least 4 A; replace if defective.

e. Installation

1. Position the fan and install four screws, Fig. 10.66.
2. Connect wire at terminal.
3. Connect negative (–) cable to the batteries.
4. Test fan operation.

10.12 CAB HEATER (ENCLOSED CAB ONLY)

10.12.1 Cab Heater Switch (Enclosed Cab Only)

The cab heater fan is only operable when the ignition switch is in the RUN position. The heater fan switch (11, Fig. 10.67) is located on the left side of the seat base.

NOTE: During summer operation, close the heater line shut-off valve (13) at the left corner of the engine just above the alternator.

a. Removal

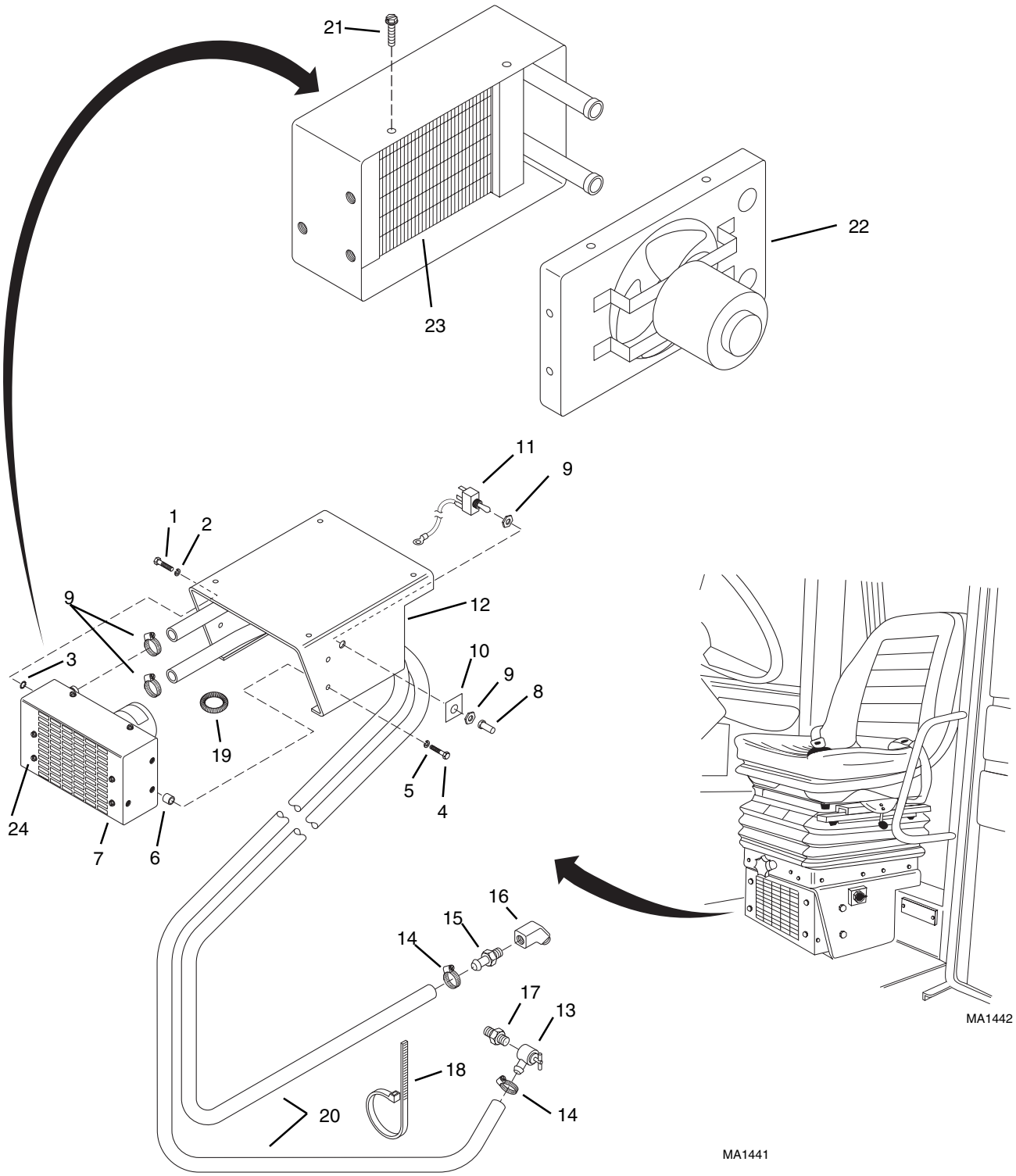
1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Remove two capscrews (1, Fig. 10.67) and lock washers (2) and tooth-type grounding washers (3).
3. Remove two capscrews (4), lock washers (5) and spacers (6).
4. Slide heater and fan unit (7) forward to provide access to the cab heater switch (11).
5. Tag and disconnect wiring from switch.
6. Remove hex nut with cap (8), knurled nut (9), decal (10), and heater switch (11) from suspension support (12).

b. Inspection and Replacement

1. Test the mechanical operation of the switch toggle; switch positions are HI, LOW and OFF.
2. Test switch for continuity in the HI and LO positions and for a short in the OFF position.
3. Replace switch if it fails to pass the tests in steps 1 and 2.

c. Installation

1. If negative (–) cable (2, Fig. 10.38) had been reconnected to the batteries, disconnect this cable.
2. Position heater fan switch (11, Fig. 10.67) in suspension support (12) and adjust knurled



1. Capscrew
2. Lock Washer
3. Tooth-Type Grounding Washers
4. Capscrew
5. Lock Washer
6. Spacer
7. Heater and Fan Unit
8. Hex Nut with Cap
9. Knurled Nut
10. Decal
11. Heater Fan Switch
12. Suspension Support
13. Valve
14. Clamps
15. Hose Connector
16. Elbow, 45°
17. Reducer
18. Tie Wrap
19. Grommet
20. Hoses
21. Sheet Metal Screws
22. Fan Mounting Bracket
23. Core
24. Sheet Metal Screws

Fig. 10.67 Removal of Optional Cab Heater Switch and Heater Fan Motor

nut (9) to provide the desired projection of the switch stem through the suspension support. Install decal (10), knurled nut (9), heater switch (11), and hex nut with cap (8).

3. Connect wiring to switch (11).
4. Slide heater and fan unit (7) into position.
5. Install two spacers (6), lock washers (5) and capscrews (4).
6. Install two tooth-type grounding lock washers (3), lock washers (2) and capscrews (1).
7. Connect negative (–) cable (2, Fig. 10.38) to the batteries.
8. Test heater fan motor operation.

10.12.2 Heater Fan Motor and Coil (Enclosed Cab Only)

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Remove two capscrews (1, Fig. 10.67), lock washers (2), and tooth-type grounding washers (3).
3. Remove two capscrews (4), lock washers (5) and spacers (6).
4. Slide heater and fan unit (7) forward to provide access to the cab heater motor and hose connections.
5. Tag and disconnect wiring from motor.
6. Open valve (13) at the left corner of the engine just above the alternator.
7. Place a clean container under the engine drain plug. Drain the coolant by venting the radiator and removing the engine drain plug.
8. At the cab heater loosen clamps (14) and disconnect hoses (20).
9. Remove heater and fan unit (7) from forklift and place it on a clean bench.

b. Disassembly

1. Disassembly of the heater unit is not required. However, if you intend to clean the heater core, remove four sheet metal screws (21, Fig. 10.67) and the fan mounting bracket (22).

IMPORTANT: *Handle core (23) with care to avoid damaging the delicate fins.*

2. Remove four sheet metal screws (21) from the front of the heater and lift the heater core from the heater.

c. Cleaning and Drying

1. Clean the interior of the heater core by connecting a hose to the inlet and flushing the core with water.
2. Soak the exterior of the heater core in a detergent solution and then flush the coil with water from a hose.
3. Allow the core to air dry.
4. Clean all parts of the heater housing with detergent in water, rinse and dry using a clean lint-free cloth.

d. Inspection and Replacement

1. Straighten bent fins using a duckbill pliers.
2. Test the heater fan motor for free rotation of the shaft. If the shaft is binding, lubricate bushing area using a few drops of an approved oil for small electric motors. Manually turn the shaft to work the oil into the bushings.
3. Test the motor by connecting a fused or protected 6 A minimum output, 12 Vdc power supply to the motor terminals using short heavy gauge wires.
4. If the motor doesn't run prepare to replace it by removing the nuts and lock washers which secure the motor to the heater.
5. Position the new motor on the heater and install the lock washers and nuts which secure it to the heater.
6. Pressure test the heater core for leakage and replace core if defective or in marginal condition.

e. Assembly

1. Position core (23, Fig. 10.67) in the heater and install four sheet metal screws (24).
2. Position fan mounting bracket (22) on heater and install four sheet metal screws (21).

f. Installation

1. If negative (–) cable (2, Fig. 10.38) had been reconnected to the batteries, disconnect this cable.
2. Position the heater and fan unit in the forklift.
3. Connect hoses (20, Fig 10.67) and install and tighten clamps (14).
4. Open valve (13).
5. Replace coolant in engine and heater lines, connect the ground cable (2, Fig. 10.38) to the negative terminals of the batteries, start the

engine, allow engine to idle for several minutes, and check for leakage at the heater connections.

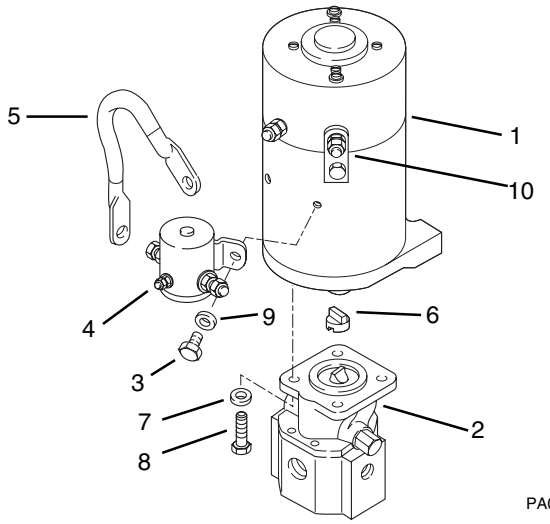
6. Disconnect battery ground cable (2, Fig. 10.38) from the negative terminals of the batteries.
7. Connect wiring to motor.
8. Prepare to electrically ground the heater unit by positioning tooth type ground washers (3, Fig 10.67) over the tapped holes in the coolant inlet/outlet side of the heater. Use a thin, transparent tape to temporarily secure the washers to the heater unit.
9. Slide heater and fan unit (7) into position under suspension support (12) without disturbing the ground washers (3) which were taped into position during the previous step.
10. Install two lock washers (5), capscrews (4) and spacers (6) at the other side of the suspension support (12).
11. Install two lock washers (2) and capscrews (1) through the holes in the suspension support (12) and through the tooth type grounding washers (3) into the tapped holes in the heater.
12. Connect negative (–) cable (2, Fig. 10.38) to the batteries.
13. Test heater fan motor operation.

10.13 EMERGENCY BRAKING AND STEERING SYSTEM

10.13.1 Low Oil Pressure Switch

The emergency pump oil pressure switch (31, Fig. 10.5) performs three functions:

- When starting the engine, the switch energizes the emergency steer pump to supply oil pressure as the engine is being started;
- When oil pressure at the engine rises above 4 psi (0,3 bar), the switch opens, stopping the emergency steer pump because the engine is turning fast enough for the tandem pump to supply sufficient hydraulic oil pressure for forklift operation.
- If engine oil pressure again falls below 4 psi (0,3 bar), the switch will close and the emergency steer pump will resume operation for as long as the battery retains a sufficient charge.



1. Motor
2. Pump
3. Screw
4. Solenoid
5. Terminal Cable
6. Coupling
7. Washer
8. Screw
9. Washer
10. Ground Strap

Fig. 10.68 Steering and Emergency Brake Pump and Motor (S/N 7P0013 and Before)

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Unlock and open right engine access door.
3. Tag and disconnect wires from terminals of emergency pump oil pressure switch.
4. Remove the switch.

b. Disassembly

Do not disassemble the engine emergency pump oil pressure switch.

c. Cleaning and Drying

Without submerging the switch, clean the switch as required by using a fiber bristle brush and an approved solvent.

d. Inspection and Replacement

1. Test the switch for continuity. It should close when oil pressure falls below 4 psi (0,3 bar). It should open when oil pressure rises above 4 psi (0,3 bar).
2. Replace the switch if it fails to pass the tests in step 1.

e. Installation

1. Install the emergency pump oil pressure switch.
2. Connect the wires to the terminals of the emergency pump oil pressure switch.

3. Connect negative (–) cable (2, Fig. 10.38) to the batteries.
4. Start the engine and inspect for oil leaks.
5. Close and lock right engine access door.

10.13.2 Steering and Emergency Hydraulic Pump (S/N 7P0013 and Before)

The emergency hydraulic pump, Fig. 10.68, performs three functions:

- When starting the engine, the emergency steer pump supplies oil pressure as the engine is being started;
- When oil pressure at the engine rises above 4 psi (0,3 bar), the emergency steer pump ceases operation because the engine is turning fast enough for the tandem pump to supply sufficient hydraulic oil pressure for forklift operation.
- If engine oil pressure again falls below 4 psi (0,3 bar), the switch will close and the emergency steer pump will resume operation for as long as the battery retains a sufficient charge.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Remove hydraulic tank cover.
3. Disconnect red electrical cable from solenoid (4, Fig. 10.68) by removing nut.
4. Tag and disconnect yellow ground wire from solenoid (4) by removing nut.
5. Tag and disconnect yellow ground wire from housing of motor (1) by removing screw.
6. Tag, disconnect, and plug the hydraulic supply hose at the pump. Cap or plug the hose end and pump ports.
7. Tag, disconnect, and plug the hydraulic pressure hose at the pump. Cap or plug the hose end and pump ports.
8. Prepare to remove pump and motor assembly by supporting assembly while an assistant removes two 3/8-16 UNC hex head capscrews.
9. Lift assembly from the forklift.

b. Disassembly

1. Disconnect black electric terminal cable (5, Fig. 10.68) by removing nuts at the solenoid (4) and at the housing of the motor (1).
2. Remove solenoid (4) by removing two 1/4-20 by 1/4" Torx head screws.
3. In warranty the pump and motor assembly is replaced as a complete unit. Out of warranty the pump and motor can be serviced as separate items. If further disassembly is required, mark the orientation of the pump to the motor and remove four screws which secure the pump (2) to the motor (1).
4. Lift pump (2) from motor (1).
5. Remove coupling (6) from pump (2).

c. Cleaning and Drying

Without submerging the motor (1, Fig. 10.68) in the cleaning solvent, clean the pump and motor assembly in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

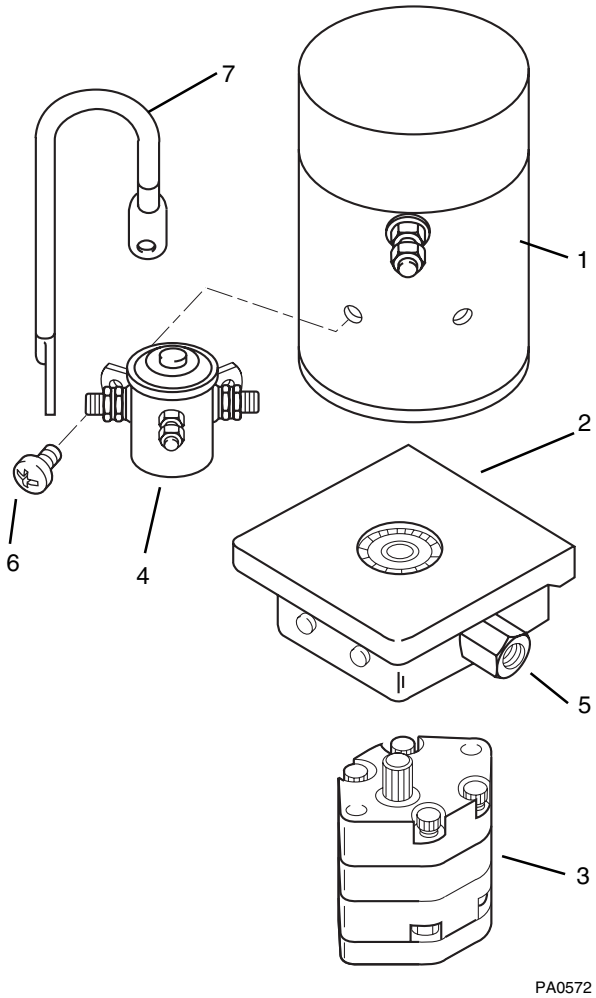
1. Inspect the pump and motor assembly.
2. Discard the complete pump or motor if the pump (2, Fig. 10.68) or motor (1) is damaged or defective.
3. Test the coil of the solenoid (4) for continuity. Discard solenoid if it is damaged or defective.
4. Test solenoid operation using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply. Discard solenoid if it fails to operate.
5. Test pump motor operation using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply. Discard motor if it fails to run.

e. Assembly

1. If pump and motor was disassembled, install coupling (6, Fig. 10.68) in pump (2).
2. Refer to the orientation marks made in paragraph b, place the pump (2) in position on the motor (1) and secure with four screws.
3. Position solenoid (4) on housing of motor (1) and install two 1/4-20 by 1/4" Torx hd screws.
4. Torque bottom nut on the ground terminal on the housing of the motor (1) to 100 lb/in (11,3 N m) maximum.
5. Connect black electric terminal cable (5) by installing nuts at the solenoid (4) and at the ground terminal on the housing of the motor (1). Torque this top nut on the ground terminal on the housing of the motor to 35 lb/in (3,9 N m) maximum.

f. Installation

1. Lower the pump and motor assembly into position and secure to machine frame.
2. Connect supply and pressure hydraulic hoses to appropriate ports in pump (2, Fig. 10.68).
3. Reconnect wiring to solenoid and motor.
4. Replace hydraulic tank cover.
5. Position the appropriate yellow ground wire on the end head assembly (2) and secure with screw.
6. Position the appropriate yellow ground wire on the solenoid (4) and secure with nut.



1. Motor
2. End Head Assembly
3. Pump
4. Solenoid
5. Check Valve
6. Taptite Screw, 1/4-20 x 1/4, Torx hd
7. Terminal Cable

Fig. 10.69 Steering and Emergency Hydraulic Pump (S/N 7P0014 thru 9B0499)

7. Position the red electrical cable on the solenoid (4) and secure with nut.
8. Connect negative (–) cable (2, Fig. 10.38) to batteries.

10.13.3 Steering and Emergency Hydraulic Pump (S/N 7P0014 thru 9B0499)

The emergency hydraulic pump (3, Fig. 10.69) performs three functions:

- When starting the engine, the emergency steer pump supplies oil pressure as the engine is being started;
- When oil pressure at the engine rises above 4 psi (0,3 bar), the emergency steer pump ceases operation because the engine is turning fast enough for the tandem pump to supply sufficient hydraulic oil pressure for forklift operation.
- If engine oil pressure again falls below 4 psi (0,3 bar), the switch will close and the emergency steer pump will resume operation for as long as the battery has sufficient charge.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.38) from the batteries.
2. Remove hydraulic tank cover.
3. Disconnect red electrical cable from solenoid (4, Fig. 10.69) by removing nut.
4. Tag and disconnect yellow ground wire from solenoid (4) by removing nut.
5. Tag and disconnect yellow ground wire from end head assembly (2) by removing screw.
6. Tag, disconnect, and plug the hydraulic supply hose at the pump. Cap or plug the hose end and pump ports.
7. Tag, disconnect, and plug the hydraulic pressure hose at the pump. Cap or plug the hose end and pump ports.
8. Prepare to remove pump and motor assembly by supporting assembly while an assistant removes two 3/8-16 UNC hex head capscrews.
9. Lift assembly from the forklift.

b. Disassembly

1. Disconnect black electric terminal cable (7, Fig. 10.69) by removing nuts at the solenoid (4) and at the housing of the motor (1).

2. Remove solenoid (4) by removing two 1/4-20 by 1/4" Torx head screws.
3. In warranty the pump and motor assembly is replaced as a complete unit. Out of warranty the pump and motor can be serviced as separate items. If further disassembly is required, mark the orientation of the pump to the motor and remove two screws which secure the pump (3) and end head assembly (2) to the motor (1).
4. Lift pump (3) from motor (1).

c. Cleaning and Drying

Without submerging the motor (1, Fig. 10.69) in cleaning solvent, clean pump and motor assembly in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect the pump and motor assembly.
2. Discard the complete pump and motor assembly if the pump (3, Fig. 10.69), end head assembly (2) or motor (1) is damaged or defective.
3. Test the coil of the solenoid (4) for continuity. Discard solenoid if it is damaged or defective.
4. Test solenoid operation using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply. Discard solenoid if it fails to operate.
5. Test pump motor operation using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply. Discard motor if it fails to run.

e. Assembly

1. If the pump and motor assembly was disassembled, place the end head assembly (2, Fig. 10.69) and pump (3) in position on the motor (1) and secure with two screws.
2. Refer to the orientation marks made in paragraph b, position the solenoid (4) on the housing of the motor (1) and install two 1/4-20 by 1/4" Torx head screws.
3. Connect black electric terminal cable (7) by installing nuts at the solenoid (4) and at the housing of the motor (1). Torque this top nut on the ground terminal on the housing of the motor to 35 lb/in (3,9 N m) maximum.

f. Installation

1. Lower pump and motor assembly into position and secure to machine frame by installing two 3/8-16 UNC hex head capscrews.
2. Connect the supply and pressure hydraulic hoses to appropriate ports in the end head assembly (2, Fig. 10.69).
3. Reconnect wiring to solenoid and motor.
4. Position the appropriate yellow ground wire on the end head assembly (2) and secure with screw.
5. Position the appropriate yellow ground wire on the solenoid (4) and secure with nut.
6. Position the red electrical cable on the solenoid (4) and secure with nut.
7. Connect negative (–) cable (2, Fig. 10.38) to the batteries.

10.14 TROUBLESHOOTING

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Trouble	Probable Cause	Remedy	Reference
Warning Devices—HORN			
Horn doesn't sound when horn button is pressed.	1. No voltage at horn (7, Fig. 10.5); broken wire or circuit breaker (11) doesn't reset.	Replace wiring and circuit breaker as required.	See para. 10.2.1
	2. Corroded electrical ground at horn mounting.	Repair electrical ground.	See para. 10.2.1
	3. Loose or broken wiring.	Repair or replace wiring.	See para. 10.2.1
	4. Defective horn switch (49, Fig. 10.5).	Test horn switch for continuity with horn button pressed; replace switch if open.	See para. 10.2.1
	5. Defective horn (7, Fig. 10.5).	Remove horn from forklift and test horn using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply.	See para. 10.2.1
Horn sounds continuously without horn button pressed.	1. Defective horn switch (49, Fig 10.5).	Test horn switch for continuity without horn button pressed; replace switch if closed.	See para. 10.2.1
	2. Short circuit in wiring.	Determine and repair cause of short circuit.	See para. 10.2.1
Warning Devices—BACKUP ALARM AND REVERSE SWITCH			
Backup alarm doesn't sound with travel select lever in REVERSE.	1. No voltage at backup alarm (16) Fig. 10.5); broken wire or circuit breaker (11) doesn't reset.	Replace wiring and circuit breaker as required.	See para. 10.2.2 and 10.4
	2. Defective reverse switch (53, Fig. 10.5).	Replace reverse switch.	See para. 10.2.2
Backup alarm sounds with travel select lever in NEUTRAL AND FORWARD.	1. Short circuit in wiring.	Determine and repair cause of short circuit.	See para. 10.3
	2. Defective reverse switch (53, Fig. 10.5).	Test and replace reverse switch as required	See para. 10.7.6
Warning Devices—PARK LOCK WARNING LIGHT			
Park lock warning bulb doesn't light when park lock brake switch is UP (engaged).	1. Park lock warning bulb (45, Fig 10.5) is burned out.	Replace park lock warning bulb.	See para. 10.7.4
	2. Loose or broken wiring.	Repair or replace wiring.	See para. 10.7.4
	3. Defective park lock brake switch (46, Fig. 10.5).	Test park lock brake switch for continuity and replace switch if open in the engaged position.	See para. 10.7.4

Trouble	Probable Cause	Remedy	Reference
Warning Devices—PARK LOCK WARNING LIGHT (cont'd)			
Park lock warning bulb lights when park lock brake switch is DOWN (disengaged).	1. Short circuit in wiring.	Determine and repair cause of short circuit.	See para. 10.8.4
	2. Defective park lock brake switch (46, Fig. 10.5).	Test park lock brake switch for continuity and replace switch if closed in the disengaged position.	See para. 10.7.4
Warning Devices—WARNING LIGHTS			
Bulbs in warning lights gauge don't light when test button is pressed.	1. Bulbs are burned out.	Replace bulbs.	See para. 10.8.4
	2. No voltage at warning lights gauge (51, Fig. 10.5); loose or broken wiring or circuit breaker (12) doesn't reset.	Replace wiring and circuit breaker as required.	See para. 10.4
	3. Defective sender switches.	Test switches for continuity under the appropriate conditions and replace as required.	See para. 10.8.5 thru 10.8.8
Bulbs in warning lights gauge light continuously when ignition key switch is in the RUN position.	1. Defective test switch (47, Fig. 10.5).	Check test switch for continuity and replace switch if closed in the released position.	See para. 10.8.4
	2. Short circuit in wiring.	Determine and repair the cause of the short circuit.	See para. 10.8.4
	3. Defective sender switches.	Test switches for continuity under the appropriate conditions and replace as required.	See para. 10.8.5 thru 10.8.8
CIRCUIT BREAKERS			
Loss of electrical power for some but not all forklift operations.	No voltage at these operations caused by a broken wire or switch, or a circuit breaker which doesn't reset to its closed position.	Replace wiring, switch and circuit breaker as required.	See para. 10.4
Circuit breaker continuously trips.	Check the system for shorts, grounds or defective electrical components.	Repair or replace as required.	See para. 10.4
Overheating and burnout of wiring and forklift electrical components.	Circuit breaker remains closed during an overload condition or is illegally bypassed with a jumper. ***Important:*** *Never jumper a circuit breaker without providing an equivalent protective devise in the jumper.*	Correct the cause of the overload and replace damaged wiring, components and circuit breaker	See para. 10.4

Starting System—GENERAL

Trouble	Probable Cause	Remedy	Reference
Engine will not crank and starting motor relay or solenoid does not engage.	1. Battery is discharged.	Check battery and charge or replace battery.	See para. 10.6.2
	2. Ignition switch, relay or solenoid inoperative.	Check circuitry and repair or renew faulty components.	See para. 10.7.1
	3. Starting circuit is open or has high resistance.	Check circuit connections and repair or renew faulty wiring.	See para. 10.5.1 and 10.5.2
Starter relay closes and solenoid engages but engine will not crank.	1. Battery is discharged.	Check battery and charge or renew.	See para. 10.6.2
	2. Defective starting motor connections or loose battery connections.	Check, clean and tighten connections.	See para. 10.5.1 and 10.6.2
	3. Starting motor faulty.	Inspect, repair or renew.	See para. 10.5.3
	4. Relay or solenoid contacts are burned.	Renew relay or solenoid.	See para. 10.5.3 and 10.5.4
	5. Engine is seized; crankshaft cannot rotate.	Repair or replace engine and transmission as required.	Section 8
Starting motor turns but does not crank engine.	1. Defective starting motor drive assembly.	Inspect and repair or renew.	See para. 10.5.3
	2. Defective solenoid or pinion engagement levers.	Inspect and repair or renew.	See para. 10.5.3
	3. Defective flywheel ring gear.	Inspect and renew.	See para. 10.5.3
Engine cranks slowly.	1. Discharged battery.	Check battery and charge or renew.	See para. 10.6.2
	2. Excessive resistance in starting circuit.	Check circuit connections and repair or renew faulty wiring.	See para. 10.5.2
	3. Defective starting motor.	Inspect and repair or renew.	See para. 10.5.3
	4. Excessively tight engine.	Investigate cause and repair or replace engine.	Section 8
Engine turns over but fails to start.	1. Fuel tank is empty.	Fill fuel tank.	See para. 8.4.2
	2. Engine is malfunctioning.	Contact authorized engine dealer.	See para. 8.7

Trouble	Probable Cause	Remedy	Reference
Starting System—STARTER			
Starter doesn't run or doesn't run correctly.	1. Discharged batteries.	See corrections for problem of discharged batteries.	See para. 10.6.2
	2. Bad connections, wires, cables or other parts in the starting circuit.	See troubleshooting the “Starting system—General”.	
	3. Using the wrong engine oil for cold weather operation.	Refer to paragraph 8.1, Engine Lubrication instructions.	See para. 8.1
	4. Worn teeth on the starter drive pinion or the flywheel ring gear.	Remove the starter to check the teeth. Repair as necessary.	See para. 10.5.3.h
	5. Hex nuts that fasten the starter to the flywheel housing are loose.	Tighten the hex nuts.	See para. 10.5.3.h
	6. Worn or damaged parts inside the starter.	Refer to paragraph 10.5.3.e DO NO LOAD TEST.	See para. 10.5.3.e
	7. Damaged coils or contacts in the starter solenoid.	Perform starter solenoid tests.	See para. 10.5.3.e
Starting System—STARTING MOTOR RELAY			
No voltage at starter solenoid when ignition key switch is in the START position.	Starter relay (36, Fig 10.5) is not energized due to broken wiring or a defective circuit breaker (10).	Replace wiring or circuit breaker.	See para. 10.5.4
Starter operates continuously without ignition key in the START position.	Starter relay (36, Fig 10.5) is “frozen” in the closed position.	Temporarily disconnect wiring to starter relay and replace starter relay.	See para. 10.5.4

Trouble	Probable Cause	Remedy	Reference
Starting System—THERMO START PLUG FOR COLD WEATHER STARTING			
Intake manifold remains cold after ignition key switch is momentarily turned to THERMO START position.	1. Discharged batteries.	Charge batteries only if electrolyte is not frozen; if frozen, remove batteries from forklift, completely thaw and then charge.	See para. 10.6.2
	2. Broken wiring or circuit breaker (10, Fig 10.5).	Replace wiring or circuit breaker.	See para. 10.4
	3. Loose connections.	Tighten connections.	See para. 10.5.5
	4. Clogged or bent fuel line to Thermo Start plug.	Clean or replace fuel line.	See para. 10.5.5
	5. Defective plug.	Replace Thermo Start plug.	See para. 10.5.5
	6. Broken ignition switch.	Remove and test ignition switch in all positions; replace if defective.	See para. 10.7.1
Intake manifold remains abnormally hot during normal engine operation.	Thermo Start plug is ON continuously due to broken ignition switch or a short circuit in the wiring.	Remove and test ignition switch in all positions; replace if defective.	See para. 10.7.1
Charging System—GENERAL			
Visual Check	1. Check for loose or corroded connections.	Repair as necessary.	See para. 10.6
	2. Check the condition and adjustment of the alternator belts.	Install a new set of drive belts if necessary; refer to paragraph 8.1.2 for belt adjustment instructions.	See para. 8.1.2 and 10.6.1
	3. Check the condition of the batteries.	Refer to “Charging System—Batteries”.	See para. 10.6.2
	4. Check for voltage at the terminals on the alternator.	Refer to paragraph 10.6.1.b for alternator troubleshooting procedures.	See para. 10.6.1.b
Charging System—ALTERNATOR			
Noise coming from the alternator.	1. Damaged or worn drive belt.	Install new drive belt.	See para. 8.1.2 and 10.6.1
	2. Damaged or loose pulley on the alternator.	Remove the pulley and check for damage to the rotor shaft and pulley; install new parts as required.	See para. 8.1.2 and 10.6.1
	3. Worn or damaged bearings in the alternator.	Disassemble the alternator and replace bearings as required.	See para. 10.6.1

Trouble	Probable Cause	Remedy	Reference

Charging System—BATTERIES

Warning !

- Wear safety glasses when working near batteries.
- Keep batteries out of the reach of children.
- Never wear rings, metal watch bands or other items that may ground a live circuit.
- All lead-acid batteries generate hydrogen gas which is highly explosive and flammable. If ignited by a spark or flame, the gas may explode violently causing spraying of acid, fragmentation of the battery, and possible severe personal injuries, particularly to the eyes.
- Never cause sparks to occur or smoke near batteries that are charging or have been recently charged. Keep sparks, flame and smoking materials away. Ventilate when charging or using in enclosed area. Always shield eyes when working near a battery.
- Avoid battery acid. Batteries contain sulfuric acid. Antidote: EXTERNAL—In case of contact with acid, flush immediately with water. INTERNAL—drink large quantities of water or milk. Follow with milk of magnesia, beaten egg, or vegetable oil. Call physician immediately. DO NOT give fluids that would induce vomiting. EYES—Flush with water for 15 minutes and get prompt medical attention.
- Never use booster batteries to start the engine or try to charge the battery if the electrolyte in the battery is frozen.
- Charge batteries only in a well-ventilated area. Always be sure battery chargers are OFF when connecting to or disconnecting from batteries.
- See Delco Remy Service Bulletin 1B115 and 1B-116 for additional safety information and procedures.

IMPORTANT: *The diodes in the alternator function as one-way valves and the transistors in the voltage regulator operate as fast switches. Both are accurate and sensitive. They do not wear out and cannot be adjusted, but because they are sensitive to voltage changes and high temperature, the following precautions are vital to prevent them from being destroyed:*

- Disconnect the ground cable first when you disconnect the battery cables from the battery; connect the ground cable last when you connect the battery cables to the battery.
- Always connect POSITIVE TO POSITIVE, NEGATIVE TO NEGATIVE.
- DO NOT disconnect the battery while the engine is running. This will cause a voltage surge in the alternator charging system that will immediately ruin the diodes or transistors.
- DO NOT disconnect a lead without first stopping the engine and turning all electrical switches to the OFF position.
- DO NOT cause a short circuit by connecting leads to incorrect terminals. Always identify a lead to its correct terminal. A short circuit or wrong connection giving reverse polarity will immediately and permanently ruin transistors and diodes.
- DO NOT connect a battery into the system without checking for correct polarity and voltage.
- DO NOT “flash” connections to check for current flow. No matter how brief the contact the transistors may be ruined.
- If a battery-caused cranking complaint exists with a clear or light yellow indication, replace the battery. In this case the charging system should be checked; refer to charging system instructions in this manual. Excessive over-charging, broken case or tipping the battery over 45° on its side will result in loss of electrolyte level.

Batteries test good but don’t perform satisfactorily in service.	Refer to possible causes in paragraph 10.6.2.f.	Provide a remedy for the cause of the trouble.	See para. 10.6.2.f

Trouble	Probable Cause	Remedy	Reference
Charging System—BATTERIES (cont'd)			
Discharged batteries.	1. Short circuit in battery cell or cells.	Refer to paragraph 10.6.2.d and perform battery load test.	See para. 10.6.2.d
	2. Loose or dirty battery cable connections.	Clean the clamp on the battery cables and the battery posts.	See para. 10.6.2.i
	3. Dirty battery top.	Refer to paragraph 10.6.2.i and clean the top of the battery.	See para. 10.6.2.i
	4. Low output or no output from alternator.	Refer to paragraph 10.6.1 and test alternator.	See para. 10.6.1
	5. High resistance in the positive battery cable.	Refer to paragraph 10.6.2 and check the positive battery cable (Test No. 3).	See para. 10.6.2 and 10.5.2.d
	6. High resistance in the negative battery cable.	Refer to paragraph 10.6.2 and check the negative battery cable (Test No. 5).	See para. 10.6.2 and 10.5.2.f
Switches and Solenoids—IGNITION (KEY) SWITCH			
Key binds in ignition switch lock.	Sticky, painted or bent key.	Clean, remove paint and straighten, remove any burrs from surface of key and sprinkle powdered graphite on working surfaces of key as described in paragraph 10.7.1 ***IMPORTANT:*** *Use only graphite or a liquid lock deicer within the lock. Severe lock malfunctions may require the services of a locksmith.*	See para. 10.7.1
Key cannot enter ignition switch or cannot be turned inside lock.	Moisture within ignition switch is frozen.	Warm the ignition switch using a hair dryer or use a liquid lock deicer to lower the freezing point and evaporate the moisture within the lock.	See para. 10.7.1
Ignition switch fails to function in one or more positions.	1. Loose or broken wiring or circuit breaker (10, Fig. 10.5) doesn't reset and remains open.	Replace wiring and circuit breaker.	See para. 10.7.1
	2. Trouble in the starting circuit.	Refer to starting circuit troubleshooting.	
	3. Trouble in the THERMO START circuit.	Refer to Thermo Start plug troubleshooting.	
	4. Defective ignition switch.	Repair or replace ignition switch.	See para. 10.7.1
Ignition switch doesn't crank engine in START position.	Travel select lever is in FORWARD or REVERSE.	Move travel select lever to NEUTRAL position.	See para. 4.2.2

Trouble	Probable Cause	Remedy	Reference
Switches and Solenoids—IGNITION (KEY) SWITCH (cont'd)			
Ignition switch causes starter to crank engine but doesn't maintain engine operation in RUN position.	1. Fuel run solenoid (34, Fig. 10.5) fails to admit fuel to fuel injection pump.	Refer to fuel run solenoid troubleshooting.	See para. 10.7.3
	2. Fuel tank is empty.	Fill fuel tank.	See para. 8.4.2
Switches and Solenoids—NEUTRAL START SWITCH			
Starter fails to crank engine with travel select lever in NEUTRAL, the park lock switch DISENGAGED and ignition key switch in START.	1. Check for problems in the shift lever linkage.	Refer to shift lever linkage adjustment instructions in paragraph 4.2.2.	See para. 4.2.2
	2. Be sure the neutral start switch is closing.	The switch closes when a switch actuating pin presses against a spring-loaded ball in the neutral start switch. Remove switch from the control valve assembly and check actuator pin for free movement in the control valve assembly. Also check for continuity with the pin pressing against the ball. If open install new switch.	See para. 10.7.2
Switches and Solenoids—FUEL RUN SOLENOID			
Ignition switch cranks engine in START but engine doesn't operate in RUN.	1. Fuel run solenoid (34, Fig. 10.5) fails to admit fuel to fuel injection pump due to loose connections or broken wiring.	Tighten connections and install new wiring as required.	See para. 10.7.3
	2. Fuel tank is empty.	Fill fuel tank.	See para. 8.4.2
	3. Fuel run solenoid is stuck in the OPEN position.	Install new fuel run solenoid.	See para. 10.7.3
Switches and Solenoids—PARK LOCK SWITCH AND PARK LOCK RELEASE VALVE SOLENOID			
Park lock switch fails to disengage park lock brake in disengaged position.	1. Loose connections or broken wiring.	Tighten connections and install new wiring as required.	See para. 10.7.4
	2. Park lock switch isn't closed in the disengaged position.	Repair or replace park lock switch if it isn't closed in the disengaged position.	See para. 10.7.4
	3. Solenoid fails to shift when park lock switch is moved from ENGAGED to DISENGAGED.	If solenoid fails to shift, refer to paragraph 10.7.5 and repair or replace the park lock release valve solenoid.	See para. 10.7.5

Trouble	Probable Cause	Remedy	Reference
Switches and Solenoids—PARK LOCK SWITCH & PARK LOCK RELEASE VALVE SOLENOID (cont'd)			
Park lock switch fails to engage park lock brake in engaged position	1. Park lock switch should be open in the engaged position.	Repair or replace park lock switch if it isn't open in the engaged position.	See para. 10.7.4
	2. Listen for the shifting of the solenoid as an assistant moves the park lock switch from the disengaged to the engaged position.	If solenoid fails to shift, refer to paragraph 10.7.5 and repair or replace the park lock release valve solenoid.	See para. 10.7.5
Switches and Solenoids—REVERSE SWITCH AND BACKUP ALARM			
Backup alarm doesn't sound with travel select lever in REVERSE.	1. No voltage at backup alarm (16, Fig. 10.5); broken wire or circuit breaker (11) doesn't reset.	Replace wiring and circuit breaker as required.	See para. 10.4
	2. Defective reverse switch (53, Fig. 10.5).	Replace reverse switch.	See para. 10.7.6
Backup alarm sounds with travel select lever in NEUTRAL AND FORWARD	1. Short circuit in wiring.	Determine and repair cause of short circuit.	See para. 10.2.2
	2. Defective reverse switch (53, Fig. 10.5).	Test and replace reverse switch as required.	See para. 10.7.6
Switches and Solenoids—STEERING SELECT SWITCH AND SOLENOID			
Steering select switch fails to select mode or selects incorrect steering mode.	1. Short circuit or broken wire.	Eliminate short or repair or replace wire.	See para. 10.7.7
	2. Circuit breaker (12, Fig. 10.5) stuck in open position.	Replace circuit breaker.	See para. 10.4
	3. Steering select switch (48, Fig. 10.5) is defective.	Remove steering select switch and check for continuity in each position and replace switch if defective.	See para. 10.7.7
	4. Steering select solenoid (55, Fig. 10.5) is defective.	Remove steering select solenoid and test for correct operation.	See para. 10.7.8
Gauges and Indicator Lights—HOURMETER			
Hourmeter Doesn't Operate.	1. Defective wiring and ground.	Renew wiring and correct ground.	See para. 10.8.3
	2. Incorrect voltage at meter terminals.	Required voltage is 9 to 36 Vdc.	See para. 10.8.3
Hourmeter is Inaccurate.	Check running indicator flag wheel.	Replace hourmeter if defective.	See para. 10.8.3

Trouble	Probable Cause	Remedy	Reference
Gauges and Indicator Lights—WARNING LIGHTS			
Bulbs in warning lights gauge fail to light when test button is pressed.	1. Bulbs are burned out.	Replace bulbs.	See para. 10.8.4
	2. No voltage at warning lights gauge (51, Fig 10.5); loose or broken wiring or circuit breaker (12) doesn't reset.	Test switches for continuity under the appropriate conditions and replace as required.	See para. 10.8.4 thru 10.8.8
	3. Defective sender switches.	Replace switches.	See para. 10.8.5 thru 10.8.8
Bulbs in warning lights gauge light continuously when ignition key switch is in RUN position.	1. Defective test switch (47, Fig. 10.5).	Check test switch for continuity and replace switch if closed in the released position.	See para. 10.8.4
	2. Short circuit in wiring.	Determine and repair the cause of the short circuit.	
	3. Defective sender switches.	Test switches for continuity under the appropriate conditions and replace as required.	See para. 10.8.5 thru 10.8.8
Gauges and Indicator Lights—ENGINE LOW OIL PRESSURE SWITCH			
Oil Pressure Indicator does not go out when the engine is running.	If the oil level and oil pressure are good and voltage is zero at wire 16, Fig. 10.5, check for shorts to ground.	If there are no shorts to ground, install a new oil pressure switch.	See para. 10.8.5
With a good oil pressure indicator bulb and the ignition key in RUN, oil pressure indicator does not light before engine is started.	1. Oil pressure switch (29, Fig. 10.5) should be closed.	If open, replace oil pressure switch.	See para. 10.8.5
	2. There is battery voltage at wire 16, Fig. 10.5, with the ignition key in RUN and the engine not running.	Install a new oil pressure switch.	See para. 10.8.5
Gauges and Indicator Lights—LOW OIL PRESSURE SWITCH FOR STEERING AND EMERGENCY HYDRAULIC PUMP			
Steering and emergency hydraulic pump fails to operate when engine oil pressure is low.	1. Oil pressure switch (31, Fig. 10.5) should be closed.	If open, replace oil pressure sender/switch.	See para. 10.8.5
	2. There is battery voltage at wire 4, Fig. 10.5, with the ignition key in RUN and the engine not running.	Install a new oil pressure switch.	See para. 10.8.5
Steering and emergency hydraulic pump operates when engine oil pressure is normal.	1. Oil pressure switch (31, Fig. 10.5) should be open.	If closed, replace oil pressure switch.	See para. 10.8.5
	2. There is battery voltage at wire 4 with the ignition key in RUN and the engine not running.	Install a new oil pressure sender/switch.	See para. 10.8.5

Trouble	Probable Cause	Remedy	Reference
Gauges and Indicator Lights—ENGINE COOLANT HIGH TEMPERATURE SWITCH			
Coolant high temperature indicator bulb fails to light when the test switch is pressed or the engine is overheated.	Coolant high temperature indicator bulb is burned out.	Replace bulb.	See para. 10.8.4
Coolant temperature warning bulb lights when the engine is running but not overheated.	1. Remove the terminal at the coolant temperature switch (15, Fig. 10.5).	If the indicator bulb goes out, install a new coolant temperature switch.	See para. 10.8.6
	2. If the indicator remains on, check wire 15 and the ignition switch for a short to ground.	If there is a short to ground, remedy the cause of the short.	See para. 10.8.6
Gauges and Indicator Lights—ALTERNATOR WARNING LIGHT			
Alternator warning bulb doesn't light when alternator isn't producing voltage.	1. Alternator not producing voltage or warning bulb is burned out.	Replace bulb.	See para. 10.8.4
	2. Battery is discharged.	Charge battery.	See para. 10.6.2
	3. Circuit breaker is stuck in open position.	Replace circuit breaker.	See para. 10.4
	4. Resistor R6 in alternator is open.	Replace resistor R6.	See para. 10.6.1.a
Gauges and Indicator Lights—TRANSMISSION HIGH OIL TEMPERATURE SWITCH			
Transmission high temperature indicator bulb fails to light when the test switch is pressed or the engine is overheated.	Transmission high temperature indicator bulb is burned out.	Replace bulb.	See para. 10.8.4
Transmission temperature warning bulb lights with the engine running but not overheated.	1. Remove the connector to the transmission temperature switch (27, Fig. 10.5).	If the indicator bulb goes out, install a new transmission high temperature sender.	See para. 10.8.8
	2. If the indicator remains on, check wire 18 and the ignition switch for a short to ground.	If there is a short to ground, remedy the cause of the short.	See Fig. 10.5

Trouble	Probable Cause	Remedy	Reference
Gauges and Indicator Lights—FUEL LEVEL GAUGE			
No indication.	1. Empty fuel tank.	Fill fuel tank.	See para. 8.4.2
	2. No current to ignition terminal because of broken or disconnected lead.	Connect lead.	See para. 10.8.9
	3. Grounded wire between sender and fuel level gauge.	Insulate wire.	See para. 10.8.9
	4. Fuel level gauge isn't grounded.	Ground receiver.	See para. 10.8.9
	5. Sender defective.	Replace sender.	See para. 10.8.9
Excessive pointer fluctuation.	1. Loose wire connections.	Tighten connectors.	See para. 10.8.9
	2. Defective sender.	Replace sender.	See para. 10.8.9
FULL reading at all times.	1. Wire to sender is broken.	Replace wire.	See para. 10.8.9
	2. Sender is not properly grounded.	Ground sender.	See para. 10.8.9
	3. Defective sender.	Replace sender.	See para. 10.8.9
Gauge indicates inaccurately.	1. Incorrect sender.	Replace sender.	See para. 10.8.9
	2. Defective sender.	Replace sender.	See para. 10.8.9
	3. Low voltage at receiver terminals.	Determine and correct cause of low voltage.	See para. 10.8.9
Pointer fluctuates when headlights are turned ON.	Engine not properly grounded.	Improve engine ground.	See para. 8.3
Optional Light Circuit—DIRECTIONAL AND EMERGENCY FLASHER SWITCH			
Turn signals operative on one side.	1. Bulb(s) burned out (flasher cannot be heard). One or more bulbs are inoperative with hazard warning system ON.	Replace bulbs.	See para. 10.9.1
	2. Open wiring or ground connector. One or more bulbs are inoperative with hazard warning system ON. Use test light and check circuit at bulb socket.	If test bulb lights, repair open ground connection; if not, repair open wiring between bulb socket and turn signal switch.	See para. 10.9.1
	3. Short to ground (flasher can be heard but no bulbs operate).	Locate and repair short to ground by disconnecting front and rear circuits separately.	See para. 10.9.1
Turn signals inoperative.	Defective flasher (located below instrument panel near brake pedal).	Replace flasher.	See para. 10.9.1

Trouble	Probable Cause	Remedy	Reference
Optional Light Circuit—MOMENTARY BRAKE LIGHT (STOP LIGHT) AND SWITCH			
Stop and tail light bulbs fail to light when brake pedal is pressed.	1. Stop and tail light bulb(s) (23, Fig. 10.53) are burned out. 2. Momentary brake switch (9) is open when brake pedal is pressed.	Replace stop and tail light bulb(s). Replace momentary brake switch.	See para. 10.9.2 See para. 10.9.2
Momentary brake bulbs remain ON when brake pedal is released.	1. Momentary brake switch (9) is closed when brake pedal is released. 2. Short in wiring.	Replace momentary brake switch. Remedy cause of short.	See para. 10.9.3 See para. 10.9.3
Optional Light Circuit—HEADLIGHT AND REAR WORK LIGHT SWITCH			
One headlight or rear work light is inoperative or intermittent.	1. Loose connection. 2. Defective sealed beam unit.	Secure connections to headlight including ground wire (black wire). Replace sealed beam unit.	See para. 10.9.4 See para. 10.9.4
One or more headlights are dim.	1. Open ground connection at headlight. 2. Black wire mislocated in headlight connector (three wire, hi-lo connector only).	Repair black wire connection between sealed beam and body ground. Relocate black wire in connector.	See para. 10.9.4 See para. 10.9.4
One or more headlights have a short life.	Charge circuit problem.	Refer to charge circuit troubleshooting.	See para. 10.6

Trouble	Probable Cause	Remedy	Reference
Optional Light Circuit—HEADLIGHT AND REAR WORK LIGHT SWITCH (cont'd)			
All lights are inoperative or intermittent.	1. Tripped circuit breaker.	Determine cause of overload and reset circuit breaker.	See para. 10.4
	2. Loose connection.	Check and secure connections at light switch.	
	3. Open wiring from light switch to battery.	Check red wire terminal at light switch with test light; if bulb doesn't light, repair open wire circuit to battery.	See para. 10.9.4
	4. Short to ground in circuit between light switch and lights.	If after a few minutes operation, lights flicker ON and OFF and a thumping noise can be heard from the circuit breaker, repair short to ground between light switch and headlights. After repairing short, check for flickering lights after one minute of operation. If flickering occurs, replace damaged circuit breaker.	See para. 10.4 and 10.9.4
	5. Defective light switch.	Check red and yellow wire terminals at light switch with test light. If bulb lights at red wire terminal but not at yellow terminal, replace light switch.	See para. 10.9.4
Windshield Washer/Wiper for Enclosed Cab—GENERAL			
Windshield wiper Inoperative.	1. Turn ignition switch to RUN and wiper switch clockwise to HIGH SPEED. Ground a 12 Vdc test lamp and touch probe to wiper or switch terminal H.	If lamp lights, continue with step 2; if lamp doesn't light, continue with step 3.	See para. 10.10.1
	2. If lamp lights, turn wiper switch to LOW, leave wiring connected to wiper motor, and connect jumper wire from motor to ground.	If wiper runs, repair open in ground strap; if wiper doesn't run, problem is in motor (refer to paragraph 10.10.3).	See para. 10.10.1 and 10.10.3
	3. If lamp doesn't light, circuit breaker (12, Fig. 10.5) may be stuck in the open position, it may be oscillating between open and closed due to a short in the circuit, or it may be in its normally closed condition.	If open, replace circuit breaker. If oscillating, check for high amperage draw due to a short in wiring or motor. If circuit breaker is closed, repair open in line 32 between circuit breaker and wiper motor or repair or replace wiper motor (33, Fig. 10.62).	See para. 10.4

Windshield Washer/Wiper for Enclosed Cab—GENERAL (cont'd)

Trouble	Probable Cause	Remedy	Reference
Windshield wiper has low speed only and is inoperative in high speed.	1. Remove connector from terminal H of wiper motor and connect a 12 Vdc source to this terminal.	If the wiper runs in high, proceed to step 2; if the wiper is inoperative, proceed to step 3.	See para. 10.10.3
	2. If wiper runs in high, check for open in red wire from switch to motor.	Repair or replace as required; if red wire provided continuity, replace wiper switch.	See para. 10.10.1
	3. If wiper is inoperative, look for a hung or grounded high speed brush in the wiper motor.	Repair or replace as required.	See para. 10.10.3
Windshield wiper has high speed only and is inoperative in low speed.	1. Remove connector from terminal L of wiper motor and connect a 12 Vdc source to this terminal.	If the wiper runs in low, proceed to step 2. If the wiper is inoperative, proceed to step 3.	See para. 10.10.3
	2. If wiper runs in low, check for open in black wire from switch to motor.	Repair or replace as required; if black wire provided continuity, replace wiper switch.	See para. 10.10.1
	3. If wiper is inoperative, look for a hung or grounded low speed brush in the wiper motor.	Repair or replace as required.	See para. 10.10.3
Wiper has one speed which is the same in both low and high.	1. Remove connectors from terminals H and L of wiper motor and connect a 12 Vdc source first to one terminal and then the other terminal.	Repair or replace as required.	See para. 10.10.3
	2. If wiper runs in high and low, check for an open in wires from wiper terminals H and L to the wiper switch.	If the wiper runs in high and low proceed to step 2; if wiper runs at one speed proceed to step 3.	See para. 10.10.3
	3. If wiper runs at one speed, check for low and high speed brush leads shorting together internally.	Repair or replace as required.	See para. 10.10.3

Windshield Washer/Wiper for Enclosed Cab—GENERAL (cont'd)

Trouble	Probable Cause	Remedy	Reference
Wiper shuts off but blades do not return to park position.	1. Remove connector from terminal P of wiper motor and connect a jumper from terminal L to P and a 12 Vdc source to terminal P.	If wiper is inoperative or doesn't park proceed to step 2; if wiper runs and parks proceed to step 3.	See para. 10.10.3
	2. If wiper is inoperative or doesn't park, check park switch actuator and brush holder assembly in wiper motor.	Repair or replace as required.	See para. 10.10.3
	3. If wiper runs and parks, use a test lamp to check for current flow between terminals P and L.	If lamp doesn't light, proceed to step 4; if lamp lights, proceed to step 5.	See para. 10.10.3
	4. If lamp doesn't light, check for open in green wire from wiper switch to wiper motor.	Repair or replace green wire as required; if green wire provided continuity, replace wiper switch.	See para. 10.10.1
	5. If lamp lights, check for open in wire 32 to circuit breaker (12, Fig. 10.5).	Repair or replace as required.	See para. 10.3
Wiper will not shut off.	Remove connectors from wiper terminals P and L. Connect a jumper from terminal P to L and a 12 Vdc source to terminal P.	If the wiper parks, replace the wiper switch; if the wiper still runs, repair wiper motor by checking the park switch actuator and the brush holder assembly.	See para. 10.10.3
Wiper runs but blades do not move.	1. Check wiper linkage connection to wiper crank arm.	If the linkage is connected, refer to step 2; if linkage is disconnected, refer to step 3.	See para. 10.10.3
	2. Wiper linkage is connected but wiper gear is stripped.	Repair wiper motor.	See para. 10.10.3
	3. Linkage is disconnected.	Connect linkage and check system.	See para. 10.10.3

Trouble	Probable Cause	Remedy	Reference
Windshield Washer/Wiper for Enclosed Cab—GENERAL (cont'd)			
Wiper motor parks but above the normal position.	1. With the ignition switch in RUN and the wiper switch in PARK, remove connector from wiper motor terminal P. Use a test lamp to check for an OPEN between terminal P to ground.	If the lamp lights, proceed to step 2; if the lamp doesn't light, proceed to step 3.	See para. 10.10.3
	2. If the lamp lights repair open in motor or replace holder assembly.	Repair or replace as required.	See para. 10.10.3
	3. If the lamp doesn't light, check arm and blade location and transmission linkage.	Repair or replace as required.	See para. 10.10.3
Windshield washer pump runs but doesn't spray fluid on windshield.	1. Reservoir is empty.	Fill reservoir.	See para. 10.10.2
	2. Washer fluid is frozen.	Use windshield washer fluid with a low freeze point for low temperature operations.	See para. 10.10.2
	3. Washer nozzle or hoses are clogged.	Clean or replace nozzle and hoses.	See para. 10.10.2
	4. Broken, kinked, or disconnected hoses.	Repair, replace, or connect hoses.	See para. 10.10.2
Windshield washer pump doesn't run.	1. Broken washer/wiper switch.	Test switch for continuity in the washer, depressed position; if switch is open, replace switch.	See para. 10.10.1
	2. Wire 33 between switch and washer pump motor is broken.	Repair or replace wire.	See para. 10.3
	3. Broken washer pump motor.	Replace washer reservoir assembly.	See para. 10.10.2
Air Circulation Fan Switch and Fan Motor for Enclosed Cab—GENERAL			
Air Circulation Fan Doesn't Run.	1. Wire 30 from circuit breaker (12) is broken.	Repair or replace wire.	See para. 10.11
	2. Fan switch or motor is broken.	Replace air circulation fan assembly.	See para. 10.11
Cab Heater for Enclosed Cab—GENERAL			
Heater doesn't produce heat with coolant at operating temperature and heater fan running.	1. Coolant shut off valve in the OFF position.	Turn shut off valve to the ON position.	See item 13, Fig. 10.67
	2. Heater hoses clogged, kinked or crushed.	Repair or replace heater hoses.	See para. 10.12.2
	3. Dirty heater core.	Disassemble heater and clean heater core as described in paragraph 10.12.1 & 10.12.2.	See para. 10.12.1 and 10.12.2

Trouble	Probable Cause	Remedy	Reference
Cab Heater for Enclosed Cab—CAB HEATER SWITCH			
Blower fan motor doesn't run.	1. Check circuit breaker.	Replace circuit breaker if open.	See para. 10.4
	2. Check continuity through blower switch in high and low positions.	Replace switch if defective.	See para. 10.12.1
	3. Check motor and fan for mechanical binding.	Realign motor and fan as required to relieve binding.	See para. 10.12.2
	4. Open heater ground at mechanical support.	Check ground at mechanical support for presence of tooth-type washer.	See para. 10.12.2
Cab Heater for Enclosed Cab—HEATER FAN MOTOR AND COIL			
Blower fan motor doesn't run.	1. Check circuit breaker.	Replace circuit breaker if open.	See para. 10.4
	2. Check motor and fan for mechanical binding.	Realign motor and fan as required to relieve binding.	See para. 10.12.2
	3. Check continuity through blower switch in high and low positions.	Replace switch if defective.	See para. 10.12.1
	4. Open heater ground at mechanical support.	Check ground at mechanical support for presence of tooth-type washer.	See para. 10.12.2 and item 3, Fig. 10.67
Hydraulic Pump for Emergency Braking and Steering—GENERAL			
Hydraulic pump fails to operate when engine oil pressure is low.	1. Low oil pressure switch is defective.	Refer to troubleshooting instructions for oil pressure switch.	See para. 10.13.1
	2. Circuit breaker is stuck in open position.	Replace circuit breaker.	See para. 10.4
	3. Defective hydraulic pump motor.	Repair or replace hydraulic pump motor.	See para. 10.13.2 or 10.13.3
	4. Hydraulic pump is defective or "frozen".	Repair or replace hydraulic pump.	See para. 10.13.2 or 10.13.3
Hydraulic pump operates when engine oil pressure is normal.	1. Low oil pressure switch is defective.	Refer to troubleshooting instructions for oil pressure switch.	See para. 10.13.1
	2. Short circuit in wiring.	Remedy cause of short circuit.	See para. 10.3

10.15 SPECIFICATIONS

RATING ..... 12 Vdc Negative Ground

NUMBER AND TYPE OF BATTERIES .....2 in parallel, Maintenance Free Lead Acid

CIRCUIT BREAKER RATINGS

Steering Select Valve ..... 6 A
Horn and Backup Alarm (Optional - Heater Fan)..... 10 A
Instrument Panel, Park Lock Switch ..... 6 A
Ignition Switch Feed for entire Electrical System..... 40 A
(Optional - Enclosed Cab) ..... 6 A
(Optional - Lighting Package) ..... 15 A

BULB QUANTITIES AND BULB NUMBERS FOR FORKLIFT:
Park Lock Brake Indicator Bulb 1 (68)
Warning Light Gauge Bulbs ..... 4 (GE 161)

BULB QUANTITY AND BULB NUMBERS FOR OPTIONAL LIGHTING SYSTEM
Headlight and Backup Light Bulbs..... 3 (4411)
Turn Signal Switch Bulb 1 (53)
Turn Signal Bulbs 2 (S1156)
Stop/Tail Bulbs 2 (1157)
Fuel Level Indicator Bulb ..... 1 (GE 1893 or 53X)

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